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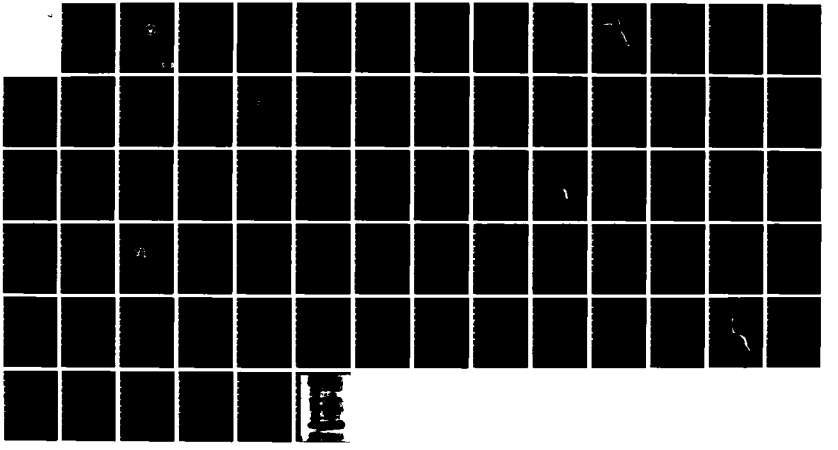

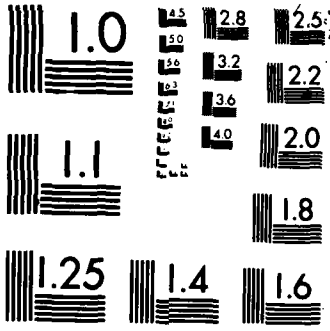

NPS68-84-002

NAVAL POSTGRADUATE SCHOOL

Monterey, California

HYDROGRAPHIC DATA FROM THE OPTOMA PROGRAM
OPTOMA2, LEGS I AND II
31 JULY - 14 AUGUST, 1982.

by

Michele M. Rienecker
Christopher N.K. Mooers
Marie C. Colton
Paul A. Wittmann

March 1984

Prepared for:
Office of Naval Research
Environmental Sciences Directorate (Code 420)
Arlington, VA 22217.

NAVAL POSTGRADUATE SCHOOL

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The cruise OPTOMA2 was undertaken in August, 1982 to sample a subdomain of the California Current System. This report presents the hydrographic data, acquired by XBT and CTD casts, from the cruise.

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Hydrographic Data from the **OPTOMA** *Program: OPTOMA2, Legs I and II*

31 July - 14 August, 1982

by

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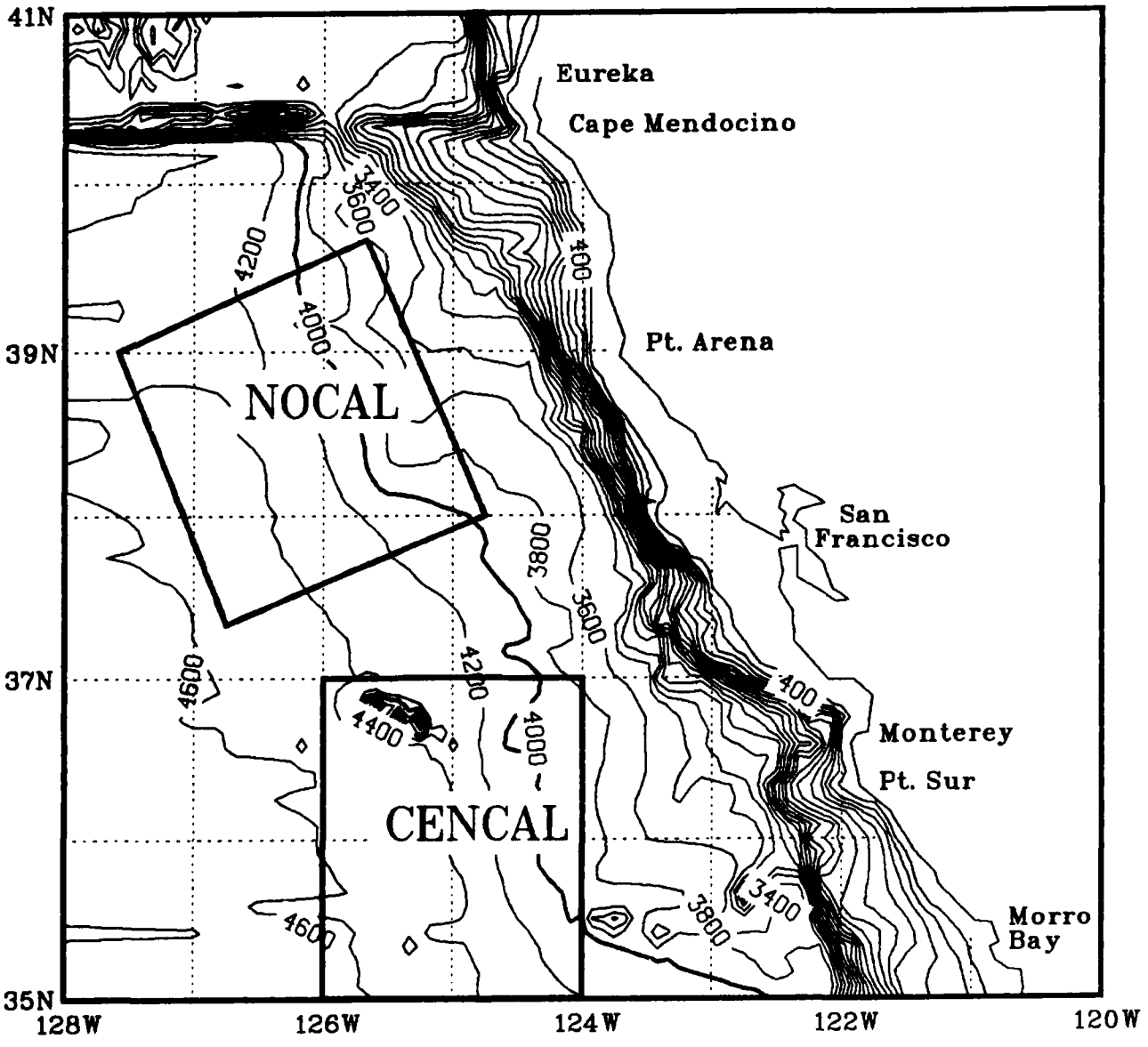


Figure 1: The NOCAL and CENCAL subdomains of the OPTOMA Program. Isobaths are shown in meters.

INTRODUCTION

The OPTOMA (Ocean Prediction Through Observations, Modeling and Analysis) Program, a joint NPS/Harvard program sponsored by ONR, seeks to understand the mesoscale (fronts, eddies, and jets) variability and dynamics of the California Current System and to determine the scientific limits to practical mesoscale ocean forecasting. To help carry out the aims of this project, a series of cruises has been planned in two subdomains, NOCAL and CENCAL, shown in Figure 1.

The cruise OPTOMA2 was undertaken, in the R/V ACANIA, for two weeks in August, 1982 and covered part of the NOCAL domain which is roughly 200 km square centered 150 km off the California coast.

Hydrographic data were acquired during two legs: Leg I was carried out during the period 31 July to 5 August and sampled an area 130 km cross-shore by 190 km alongshore with additional transects to and from the domain as shown in Figure 2. The transect extremes are identified by letter to aid in the cross-referencing of data presented in subsequent figures. Leg II was carried out during the period 8 to 14 August and sampled an area roughly 150 km cross-shore by 100 km alongshore as shown in Figure 13. Each leg consisted of a series of parallel transects directed alongshore, separated by roughly 45 km and along which hydrographic stations were occupied every 8.8 km. In addition, there were diagonal transects and tracks to and from the domain.

DATA ACQUISITION

Data acquired during OPTOMA2 include XBT and CTD profiles and continuous 2 m thermalsalinograph measurements. Bucket surface temperature and water samples for salinity were taken at every CTD station. These surface values and those at 2 m were used for calibration purposes as well as contributions to the data base. Continuous meteorological data such as atmospheric pressure at a height of 2 m and wind speed and direction at a height of 20 m were also recorded. The XBT, CTD and continuous "underway" data were digitized using an

HP 5328 frequency counter and a 40 channel digital voltmeter. The continuous data were averaged over one-minute intervals. All data were recorded, using an HP 9835 computer, on data cassettes and transferred ashore to the IBM 3033 mainframe computer for editing and processing.

Station positions were determined by Loran C fixes and are claimed to be accurate to within about 0.1 km. The probe on the Sippican Expendable Bathythermograph (XBT) has an accuracy of ±0.2C in temperature and ±2% or 4.6 m (whichever is greater) in depth. The Neil Brown Instrument Mark IIIb conductivity - temperature - depth (CTD) sensors have an accuracy of ±0.005 mmho, ±0.005C, and ±1.6db, respectively. The 2 m underway sensors are from SEA-BIRD Electronics. The temperature sensor, a glass coated thermistor bead, has an accuracy of ±0.003C; the conductivity sensor, a two-terminal flow-through electrode cell, has an accuracy of of ±0.003 mmho/cm. The bottle surface salinity samples were determined ashore by a Guildline Model 8400 "Autosal" salinometer with an accuracy of ±0.003 ppt. The Table on page 6 summarizes the various sensors available on the R/V ACANIA and their accuracy.

DATA PROCESSING

Data processing, such as estimating depth profiles for the XBT temperature profiles based on the XBT's descent speed, and conversion of CTD conductivity to salinity using the algorithm given in Lewis and Perkin (1981), was carried out on the IBM 3033 at the Naval Postgraduate School. The data were then edited by removing obvious salinity spikes and eliminating cast failures that were not identified during the cruise. Approximately 91% of casts were retained in the data set. The CTD salinity profiles were corrected by reference to the 2 m salinity and surface salinity measurements. The surface salinities from the CTD casts up to Station 110 were too high on average by 0.17 ppt; hence they were adjusted accordingly. Thereafter, the offset was random and the average difference between sensors was only 0.02 ppt; hence, no correction was made. The CTD data were interpolated to 5 m intervals and then up and down casts were averaged.

The data have been transferred on digital tape to the National Oceanographic Data Center in Washington, DC.

DATA PRESENTATION

The cruise track, station locations (with XBT's and CTD's identified) and station numbers are shown in the first three figures of each of the next two sections, which present the data from Leg I and Leg II, respectively. These figures are followed by a listing of the stations, with their coordinates, the date and time at which the station was occupied, and the surface information obtained at the station.

Vertical profiles of temperature from the XBT casts are shown in staggered fashion. The location of these profiles may be found by reference to the various maps of the cruise track. Transect extremes are identified as nearly as possible. The first profile on each plot is shown with its temperature unchanged; to each subsequent profile an appropriate multiple of 5C has been added. Vertical profiles from the CTD's follow. Profiles of temperature are staggered by 5C and those of salinity by 4 ppt.

Isotherms for each transect are shown in the next pages, followed by isopleths of temperature, salinity and sigma-t from the CTD's. Based on instrument accuracy and the vertical temperature gradient, it is estimated that the depth of isotherms in the main thermocline are uncertain to $\pm$20m. The tick marks identify station positions and, again, the transect extremes are shown on these plots. In each section, the data presentation concludes with a scatter diagram of T-S pairs, plots of mean and $\pm$ standard deviation on profiles of temperature from XBT's and CTD's and temperature, salinity and sigma-t from the CTD's, and a plot of the mean and $\pm$ standard deviation profiles of N^2 (Brunt-Vaisala frequency squared). On the sigma-t and N^2 plots, the appropriate profiles derived from the mean temperature and mean salinity profiles are also shown, but these are barely distinguishable from the mean profiles themselves.

SCIENTIFIC INSTRUMENTS ABOARD THE R/V ACANIA

Instrument	Variable	Sensor	Accuracy	Resolution
Neil Brown CTD Mark IIIb	pressure	strain gage	1.6 db	0.025 db
	temperature	thermistor	0.005 C	0.0005 C
	conductivity	electrode cell	0.005 mmho	0.001 mmho
Sippican BT	temperature	thermistor	0.2 C	
	depth	descent speed	max. of 4.6 m and 2% of depth	
Guildline Autosal	conductivity	electrode cell	0.003 ppt	0.0002 ppt
*Amatek Straza ADVP	velocity profiles to 100m	4 beam sonar	3 cm/sec relative to ship speed	3 cm/sec
*Rosemount Sensor	sea surface temperature	platinum thermometer	0.05 C	0.005 C
Sea-Bird Sensors	temperature	thermistor	0.003 C	0.0005 C
	conductivity at 2 meters	electrode cell	0.003 mmho	0.0005 mmho
Rosemount Sensor	air temperature	thermometer	0.01 C	
Kavolico Barometer	atmospheric pressure	pressure transducer	1.5 mb	0.1 mb
*1200 EPS Hygrometer	dew point	condensation temp. sensor	0.2 C	0.02 C
Meteorology Res. Inc.	wind speed	anemometer	0.15 mph or 1%	
Meteorology Res. Inc.	wind direction	vane	2.5 degrees	
Internav LC408 LORAN C	position	two chain LORAN receiver	100 meters	10 meters
Motorola Miniranger	position	microwave transponders	4 meters	2 meters

* Not operating on the OPTOMA2 cruise.

SECTION 1

OPTOMA2 - LEG I

31 JULY to 5 AUGUST 1982

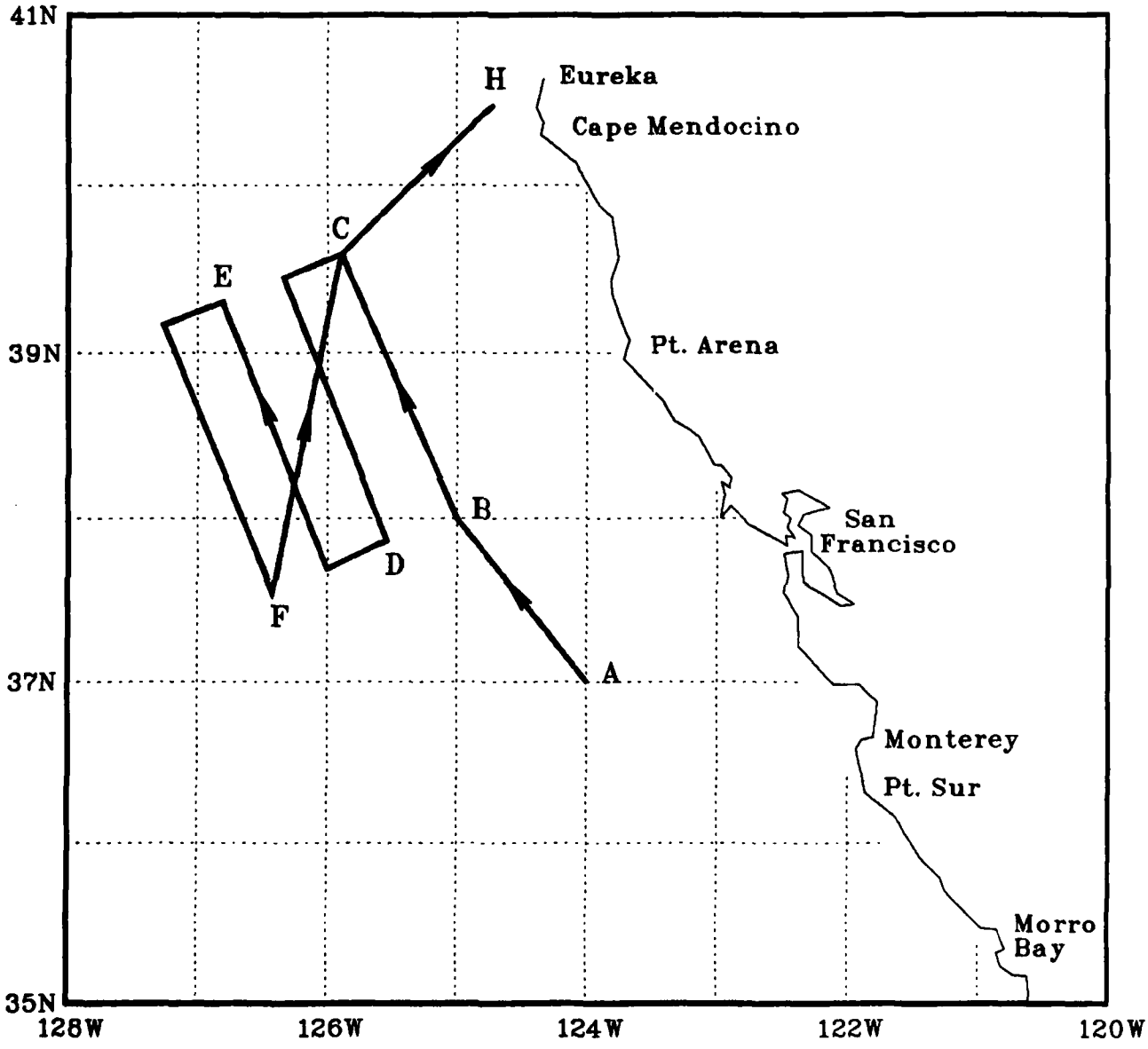


Figure 2: Cruise track for OPTOMA2, Leg I with transect extremes identified by letter.

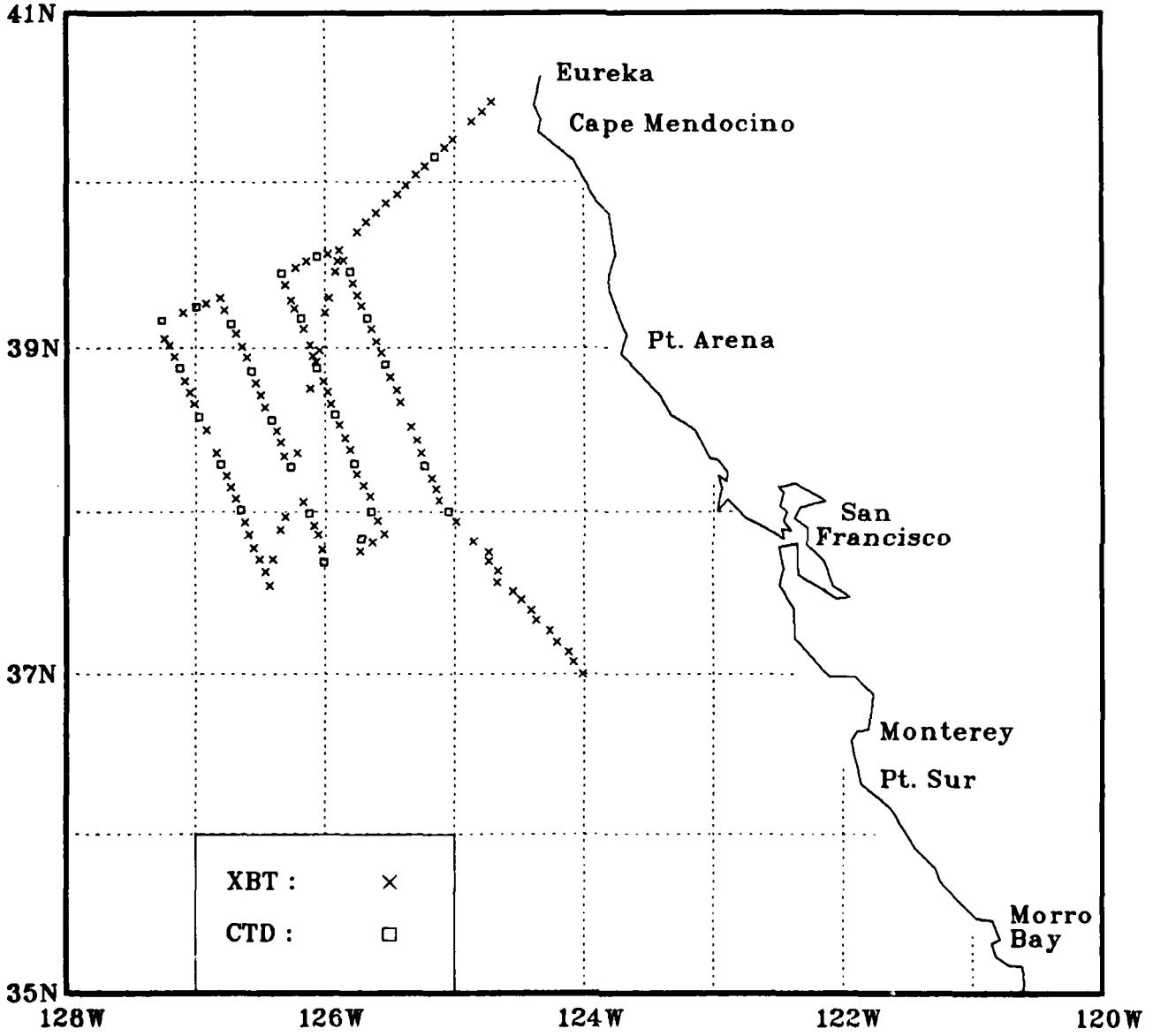


Figure 3: XBT and CTD locations for OPTOMA2, Leg I.

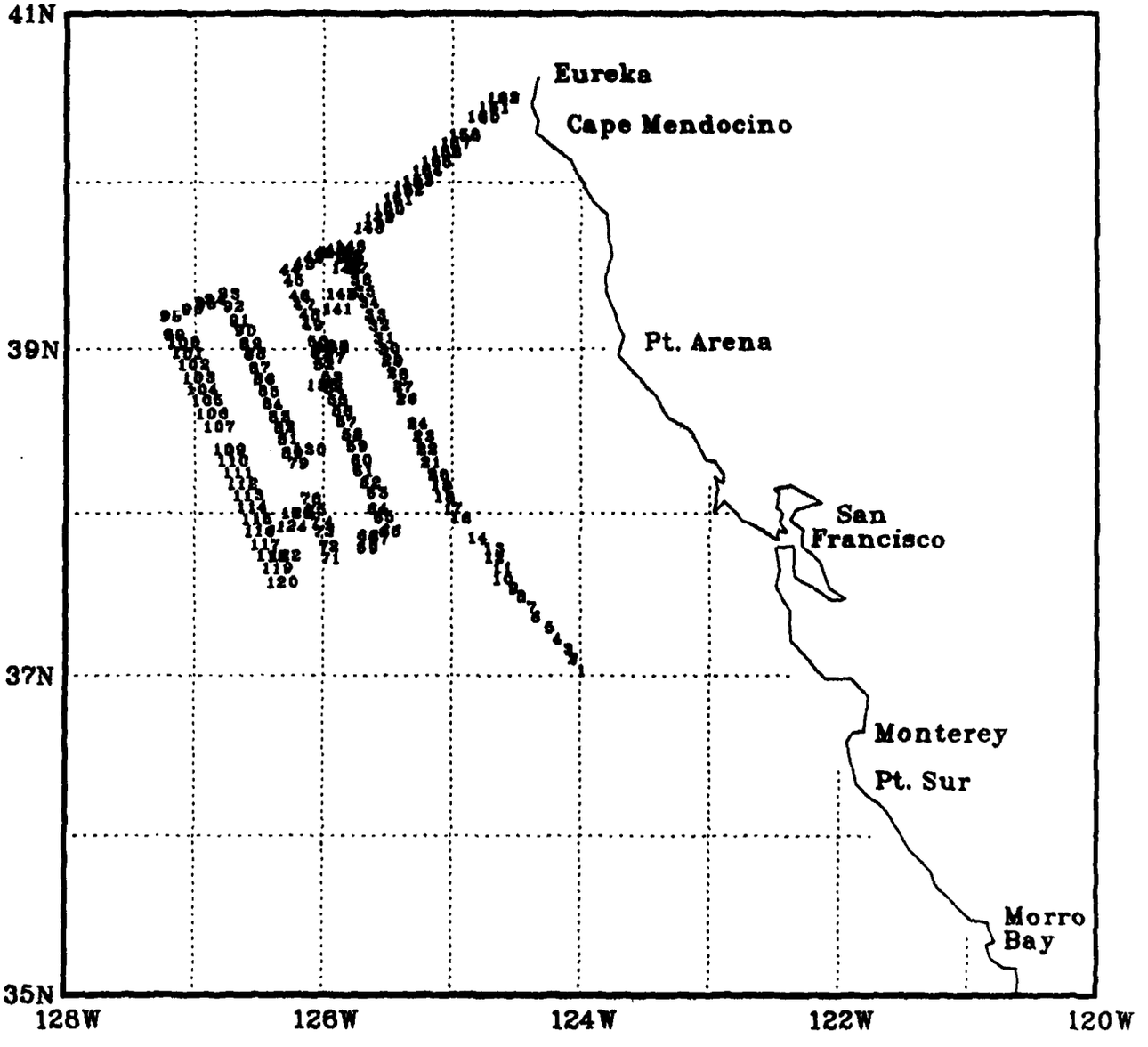


Figure 4: Station numbers for OPTOMA2, Leg I.

XBT - CTD STATION LISTING

STN	TYPE	YR/DAY	GMT	LAT (NORTH)	LONG (WEST)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINTIY (PPT)
1	XBT	82212	1526	37.00	124.01	13.9			
2	XBT	82212	1733	37.05	124.05	15.0			
3	XBT	82212	1844	37.08	124.07	15.1			
4	XBT	82212	2016	37.12	124.13	15.1			
5	XBT	82212	2132	37.16	124.16	14.8			
6	XBT	82212	2314	37.20	124.22	14.0			
7	XBT	82213	19	37.24	124.24	13.6			
8	XBT	82213	140	37.28	124.29	13.3			
9	XBT	82213	242	37.31	124.33	13.0			
10	XBT	82213	402	37.34	124.40	13.2			
11	XBT	82213	515	37.38	124.40	13.3			
12	XBT	82213	625	37.42	124.44	13.6			
13	XBT	82213	746	37.45	124.44	14.2			
14	XBT	82213	910	37.49	124.51	14.1			
16	XBT	82213	1154	37.56	124.60	15.4			
17	CTD	82213	1252	38.00	125.03	15.1	33.06	15.2	33.15
18	XBT	82213	1609	38.04	125.07	14.4			
19	XBT	82213	1649	38.08	125.09	14.6			
20	XBT	82213	1726	38.12	125.11	14.9			
21	CTD	82213	1828	38.17	125.14	14.1	33.14	15.0	33.11
22	XBT	82213	1919	38.22	125.16	12.9			
23	XBT	82213	1958	38.26	125.17	13.5			
24	XBT	82213	2035	38.31	125.20	14.2			
26	XBT	82213	2231	38.40	125.25	15.1			
27	XBT	82213	2306	38.45	125.27	15.5			
28	XBT	82213	2346	38.49	125.30	15.4			
29	CTD	82214	44	38.54	125.32	15.2	32.75	15.2	32.84
30	XBT	82214	134	38.58	125.34	15.6			
31	XBT	82214	217	39.02	125.36	15.6			
32	XBT	82214	318	39.07	125.38	15.4			
33	CTD	82214	432	39.11	125.40	15.3	32.70	15.3	32.65
34	XBT	82214	555	39.15	125.43	15.2			
35	XBT	82214	647	39.19	125.45	15.4			
36	XBT	82214	743	39.23	125.47	15.7			
37	CTD	82214	857	39.28	125.48	15.3	32.62	15.5	32.68
38	XBT	82214	1014	39.32	125.52	15.6			
40	XBT	82214	1150	39.34	125.59	15.7			
41	CTD	82214	1303	39.33	126.04	15.6	32.48	15.7	32.58
42	XBT	82214	1422	39.32	126.09	15.7			
43	XBT	82214	1453	39.29	126.14	16.1			
44	CTD	82214	1550	39.27	126.20	15.6	32.62	15.8	32.57
45	XBT	82214	1628	39.23	126.18	15.4			
46	XBT	82214	1709	39.17	126.16	15.5			
47	XBT	82214	1730	39.14	126.14	15.8			
48	CTD	82214	1813	39.11	126.11	15.2	32.69	15.4	32.62
49	XBT	82214	1850	39.07	126.10	16.1			
50	XBT	82214	1934	39.01	126.07	15.7			
51	XBT	82214	2001	38.57	126.06	15.5			

STN	TYPE	YR/DAY	GMT	LAT (NORTH)	LONG (WEST)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
52	CTD	82214	2046	38.53	126.04	14.9	32.70	14.9	32.64
53	XBT	82214	2135	38.48	126.01	15.2			
54	XBT	82214	2206	38.44	125.59	14.6			
55	XBT	82214	2301	38.40	125.57	14.7			
56	CTD	82214	2349	38.36	125.55	14.1	32.70	14.3	32.79
57	XBT	82215	32	38.32	125.54	14.2			
58	XBT	82215	108	38.27	125.51	14.0			
59	XBT	82215	145	38.23	125.49	16.2			
60	CTD	82215	238	38.18	125.47	16.5	32.82	16.5	32.76
61	XBT	82215	315	38.14	125.46	16.9			
62	XBT	82215	348	38.10	125.42	16.4			
63	XBT	82215	416	38.06	125.39	15.9			
64	CTD	82215	503	38.00	125.39	15.7	32.99	15.9	32.82
65	XBT	82215	557	37.57	125.36	15.8			
66	XBT	82215	637	37.52	125.33	15.6			
67	XBT	82215	711	37.49	125.38	15.8			
68	CTD	82215	757	37.50	125.43	15.4	32.87	15.9	32.96
69	XBT	82215	836	37.46	125.44	15.5			
71	CTD	82215	1000	37.42	126.00	15.5	32.86	15.7	32.87
72	XBT	82215	1126	37.46	126.01	15.7			
73	XBT	82215	1205	37.52	126.04	15.7			
74	XBT	82215	1231	37.55	126.05	15.7			
75	CTD	82215	1316	37.59	126.08	15.6	32.86	15.7	32.87
76	XBT	82215	1402	38.04	126.10	15.8			
79	CTD	82215	1612	38.17	126.16	16.4	32.85	16.5	32.87
80	XBT	82215	1658	38.20	126.19	15.8			
81	XBT	82215	1733	38.25	126.21	15.6			
82	XBT	82215	1803	38.30	126.22	15.5			
83	CTD	82215	1907	38.34	126.25	15.2	32.97	15.4	32.92
84	XBT	82215	2014	38.38	126.28	15.7			
85	XBT	82215	2047	38.43	126.30	14.7			
86	XBT	82215	2119	38.47	126.32	14.8			
87	CTD	82215	2200	38.51	126.34	15.5	32.60	15.5	-----
88	XBT	82215	2249	38.57	126.36	16.0			
89	XBT	82215	2317	39.00	126.39	16.3			
90	XBT	82215	2351	39.05	126.41	16.4			
91	CTD	82216	36	39.09	126.44	16.1	32.76	16.3	-----
92	XBT	82216	124	39.14	126.46	16.2			
93	XBT	82216	156	39.18	126.48	16.8			
94	XBT	82216	235	39.16	126.55	16.6			
95	CTD	82216	317	39.15	126.59	16.3	32.73	16.3	32.65
96	XBT	82216	405	39.13	127.06	17.0			
98	CTD	82216	539	39.10	127.16	16.9	32.72	17.0	32.64
99	XBT	82216	649	39.03	127.14	16.7			
100	XBT	82216	722	39.01	127.12	16.6			
101	XBT	82216	754	38.57	127.10	16.3			
102	CTD	82216	839	38.53	127.07	15.6	32.69	15.7	32.82
103	XBT	82216	927	38.48	127.05	15.6			
104	XBT	82216	958	38.44	127.03	15.7			
105	XBT	82216	1026	38.40	127.01	15.3			
106	CTD	82216	1108	38.35	126.58	15.2	32.72	15.3	32.84

STN	TYPE	YR/DAY	GMT	LAT (NORTH)	LONG (WEST)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
107	XBT	82216	1151	38.30	126.55	15.3			
109	XBT	82216	1243	38.22	126.50	15.4			
110	CTD	82216	1321	38.18	126.49	15.7	33.00	15.7	32.91
111	XBT	82216	1403	38.13	126.46	15.7			
112	XBT	82216	1432	38.09	126.44	15.7			
113	XBT	82216	1503	38.05	126.41	16.0			
114	CTD	82216	1550	38.01	126.39	16.6	32.95	16.7	33.00
115	XBT	82216	1637	37.56	126.37	16.2			
116	XBT	82216	1709	37.52	126.35	16.4			
117	XBT	82216	1744	37.47	126.33	16.2			
118	XBT	82216	1818	37.43	126.30	16.4			
119	XBT	82216	1852	37.38	126.28	16.6			
120	XBT	82216	2023	37.33	126.25	16.8			
122	XBT	82216	2138	37.43	126.24	16.6			
124	XBT	82216	2248	37.53	126.21	16.4			
125	XBT	82216	2323	37.58	126.19	16.5			
130	XBT	82217	158	38.22	126.13	16.9			
135	XBT	82217	435	38.45	126.07	15.7			
137	XBT	82217	540	38.55	126.04	15.5			
138	XBT	82217	609	38.59	126.03	16.0			
141	XBT	82217	745	39.13	125.60	16.7			
142	XBT	82217	819	39.18	125.58	16.7			
144	XBT	82217	924	39.28	125.55	16.8			
145	XBT	82217	953	39.32	125.54	16.9			
146	XBT	82217	1031	39.35	125.54	16.9			
148	XBT	82217	1135	39.42	125.45	16.7			
149	XBT	82217	1205	39.46	125.41	16.8			
150	XBT	82217	1238	39.49	125.36	16.4			
151	XBT	82217	1311	39.52	125.32	16.2			
152	XBT	82217	1343	39.56	125.26	15.8			
153	XBT	82217	1415	39.59	125.23	15.6			
154	XBT	82217	1446	40.02	125.18	15.5			
155	XBT	82217	1515	40.06	125.14	14.9			
156	CTD	82217	1600	40.09	125.09	15.2	32.87	15.3	33.00
157	XBT	82217	1642	40.12	125.05	14.9			
158	XBT	82217	1707	40.15	125.01	14.0			
160	XBT	82217	1806	40.22	124.52	12.8			
161	XBT	82217	1840	40.25	124.47	12.1			
162	XBT	82217	1909	40.28	124.43	12.1			

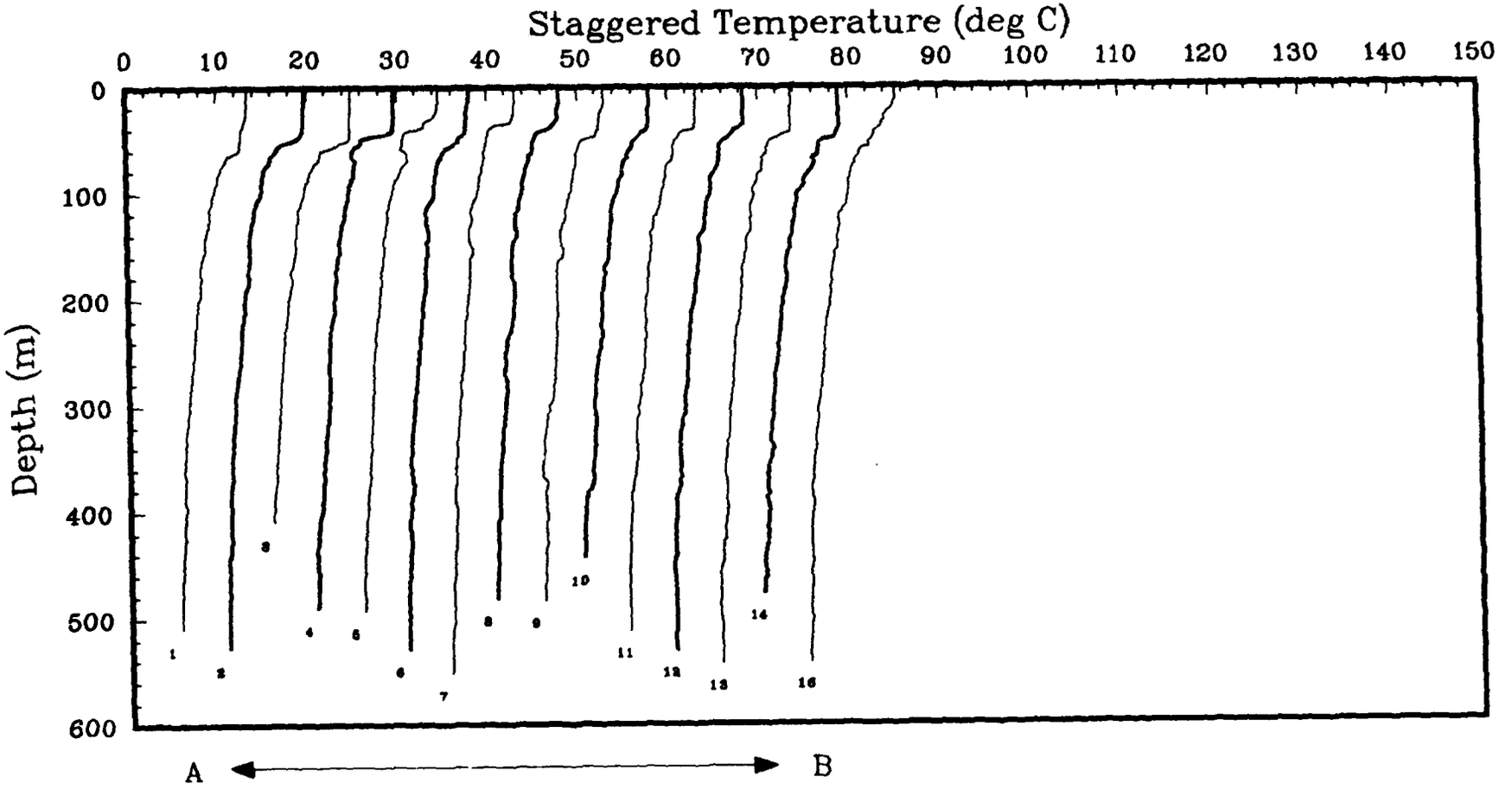


Figure 5(a): Staggered temperature profiles from the XBT's. Profiles are staggered by a multiple of 5C.

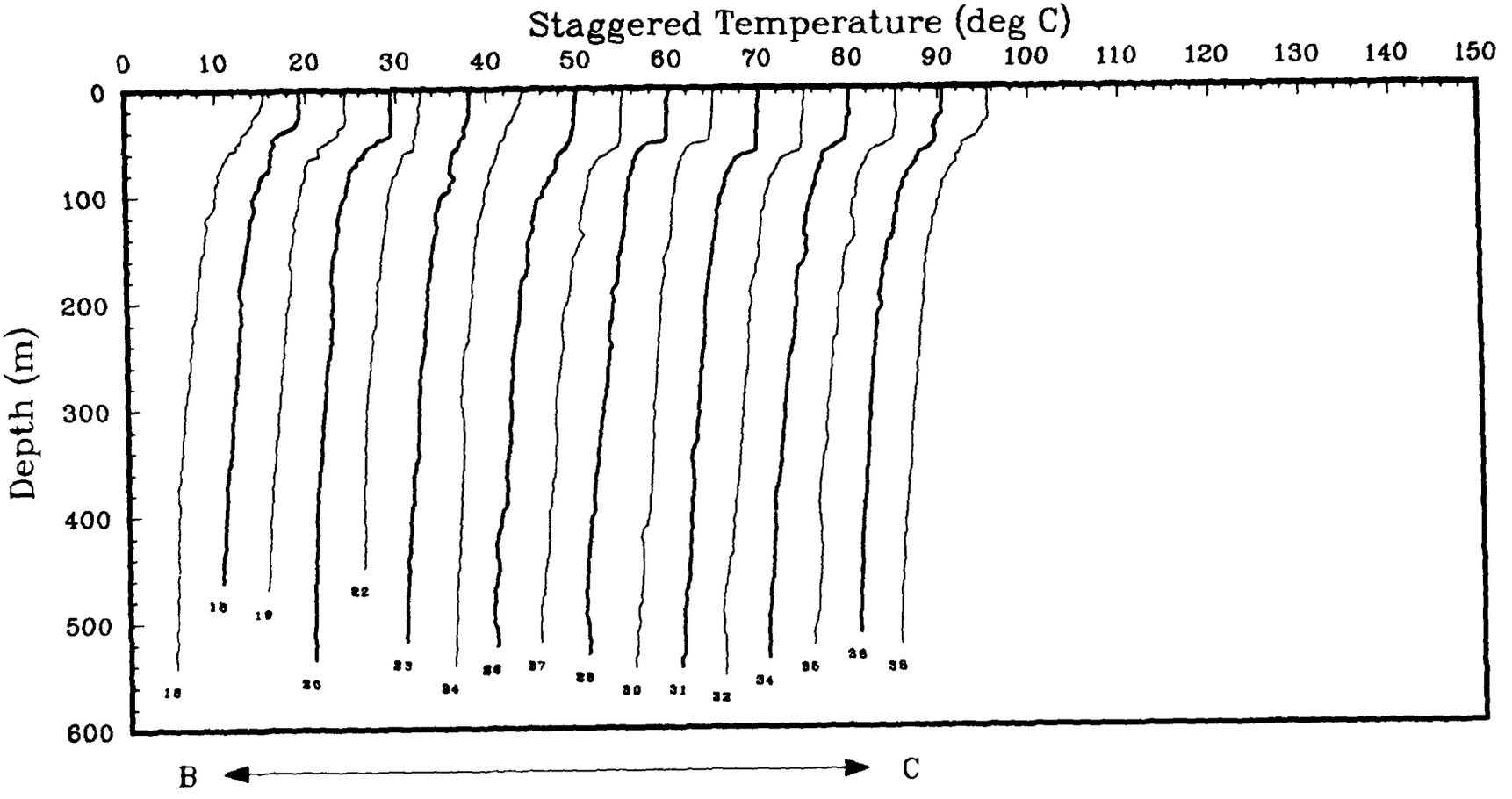

Staggered Temperature (deg C)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Depth (m)
0 100 200 300 400 500 600
18 19 20 22 23 24 26 27 28 30 31 32 34 35 36 38
B
C

Figure 5(b).

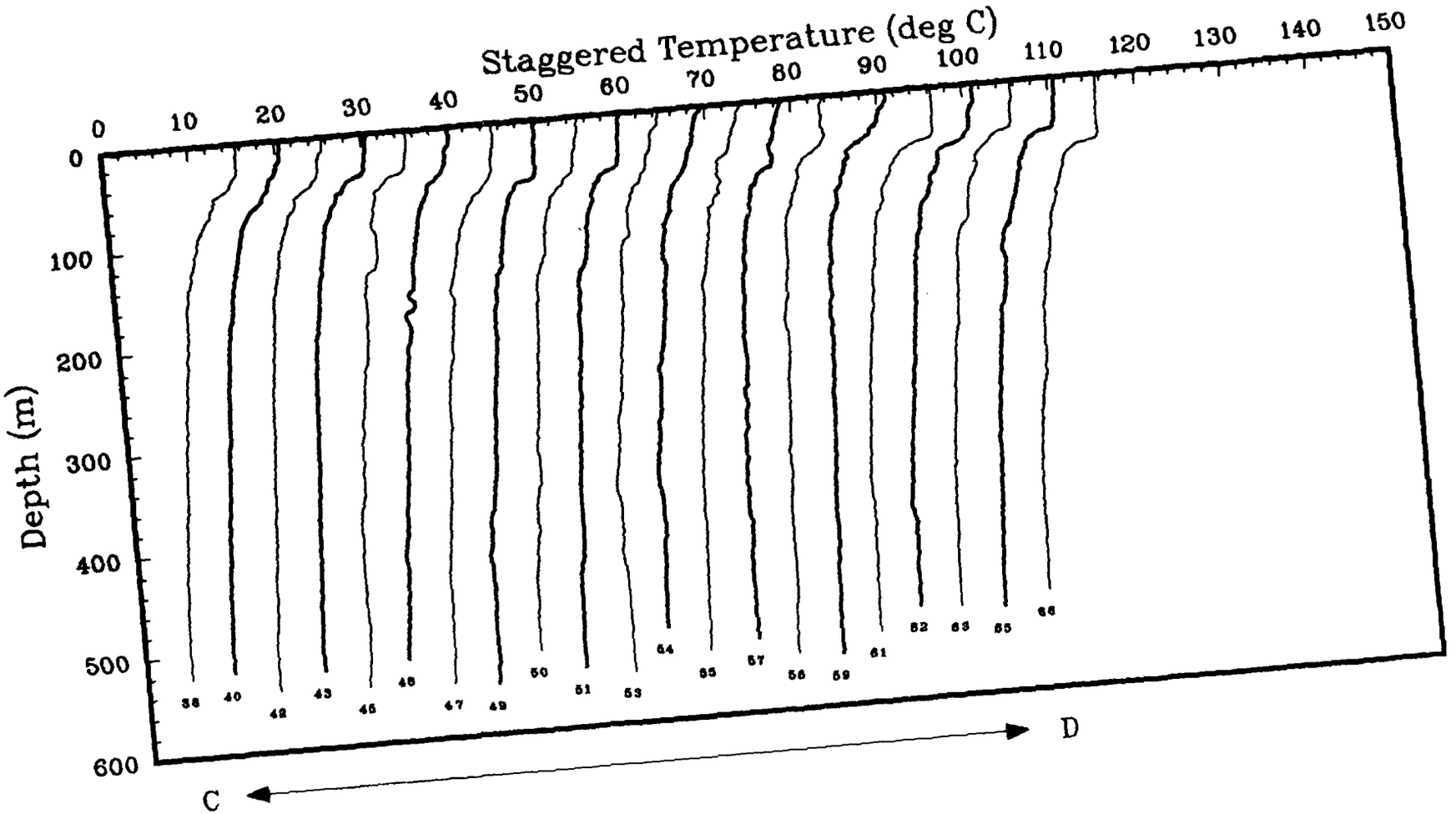

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
C
D
36
40
42
43
45
46
47
49
50
51
53
54
55
57
58
59
61
62
63
65
66

Figure 5(c).

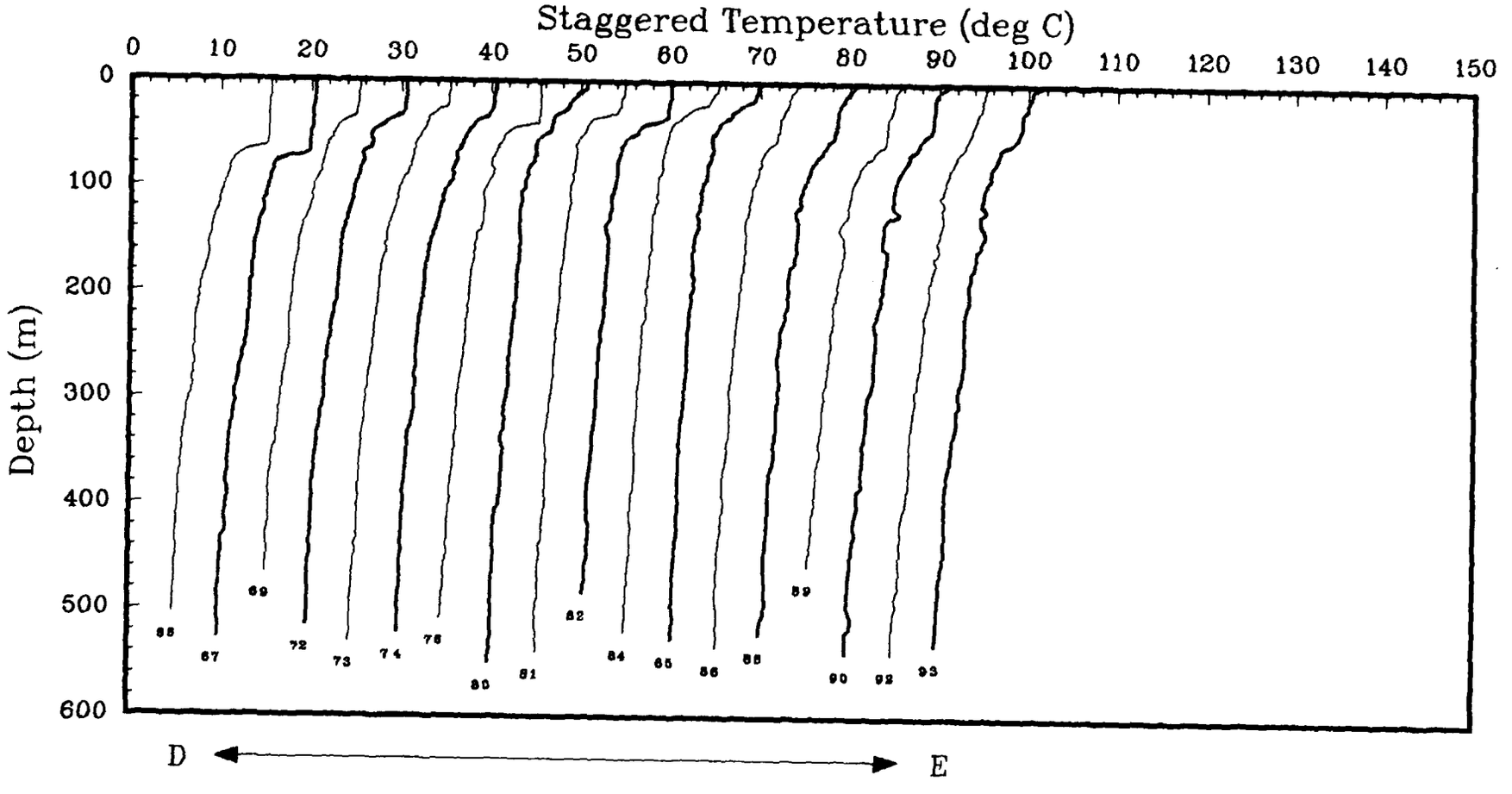
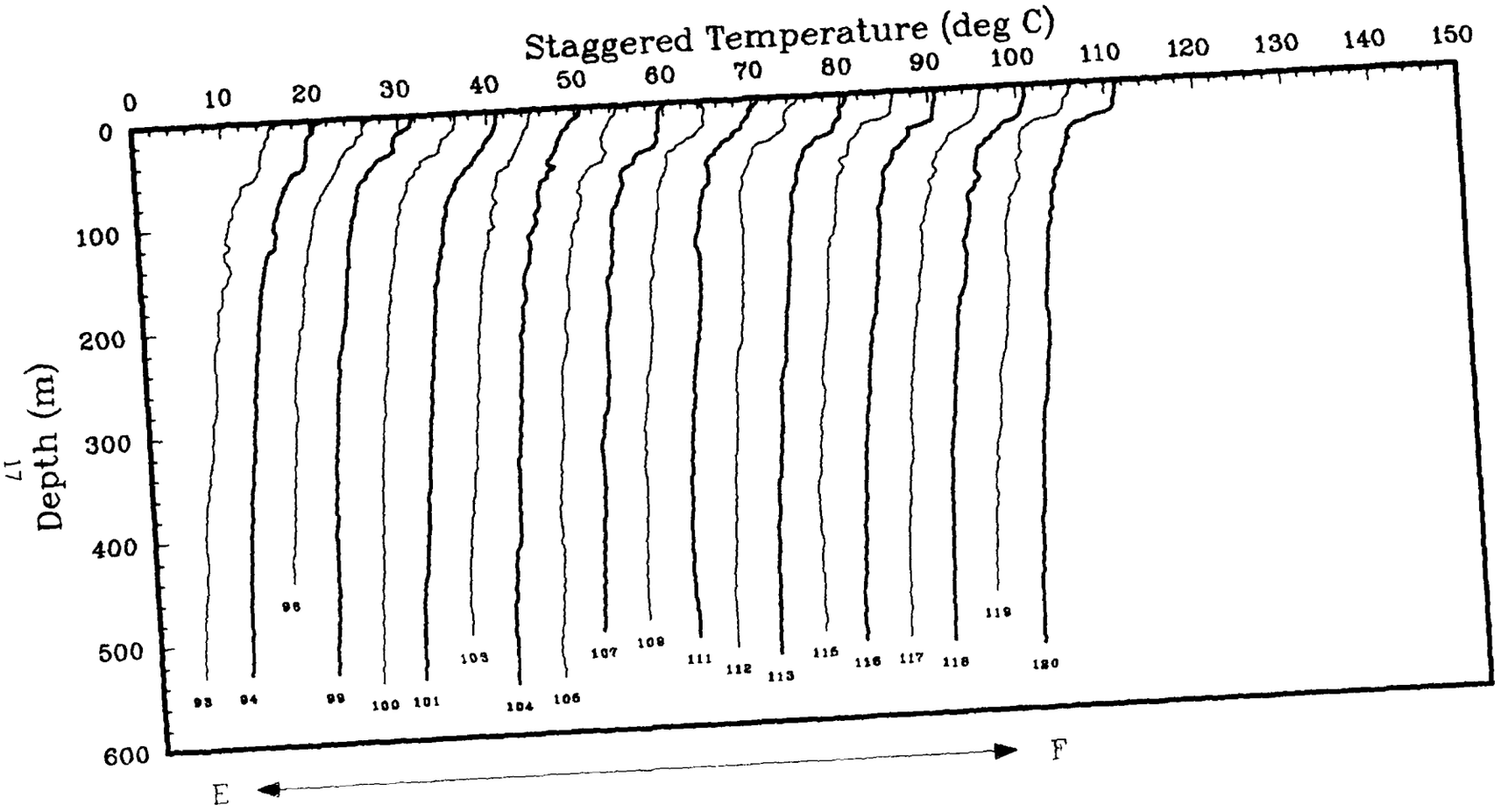

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
65
67
69
72
73
74
76
80
81
82
84
85
86
88
89
90
92
93
D
E

Figure 5(d).


Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
93
94
96
99
100
101
103
104
106
107
109
111
112
113
115
116
117
118
119
120
E
F

(Figure 5(e)).

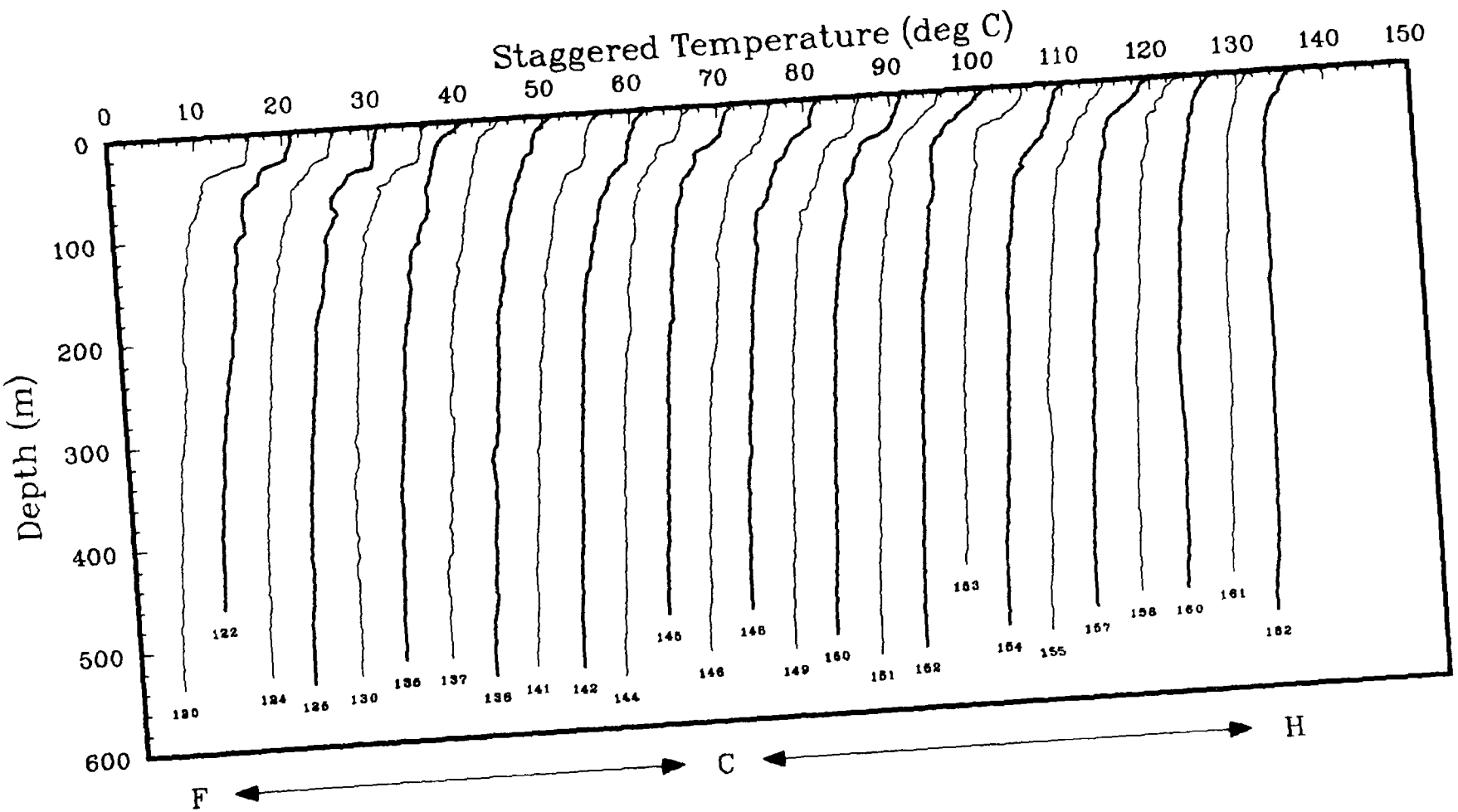

Staggered Temperature (deg C)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Depth (m)
0 100 200 300 400 500 600
120 122 124 126 130 136 137 138 141 142 144 145 146 148 149 150 151 152 153 154 155 157 158 160 161 162
F
C
H

Figure 5(f).

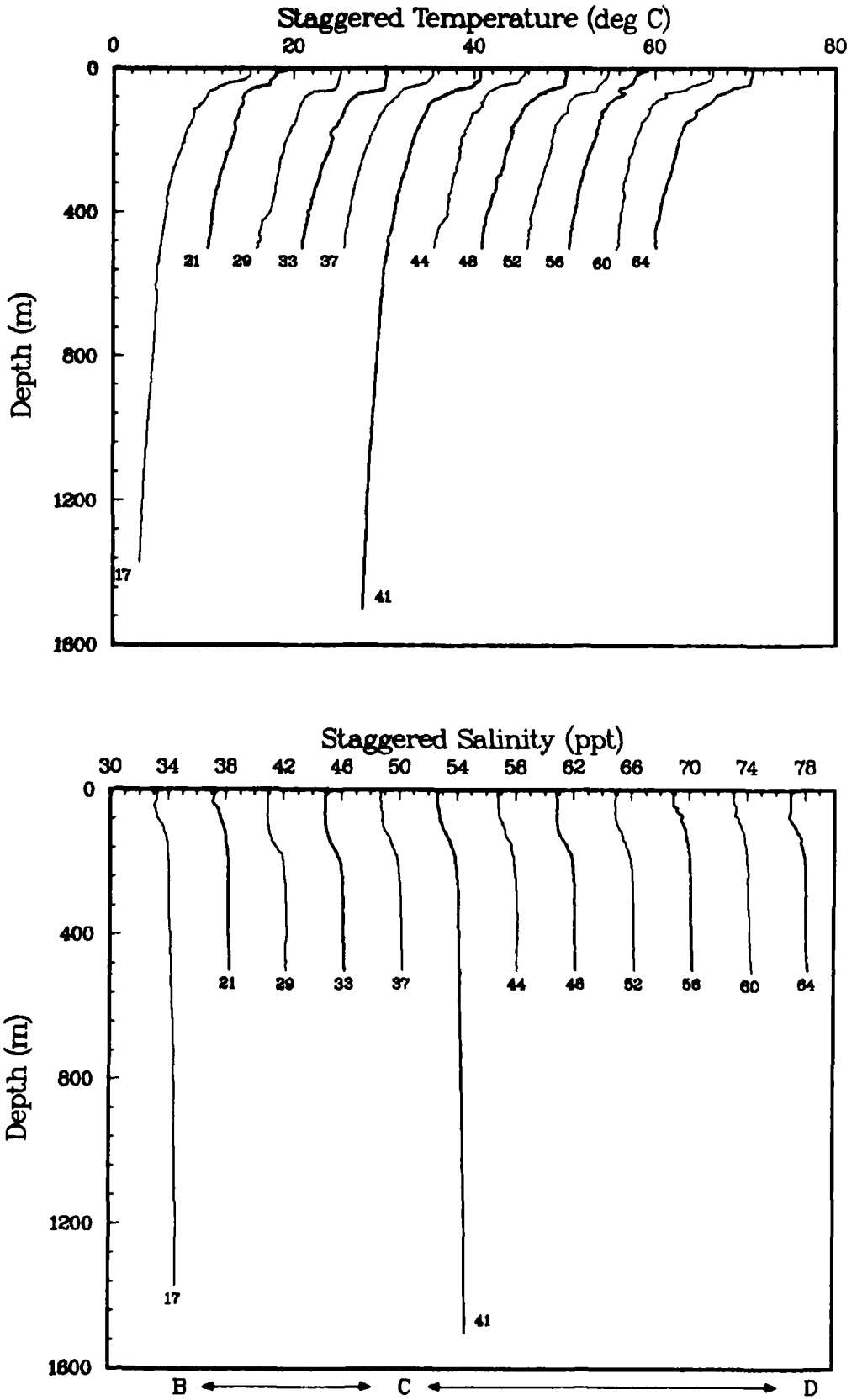


Figure 6(a): Temperature profiles, staggered by multiples of 5C, and salinity profiles, staggered by multiples of 4 ppt.

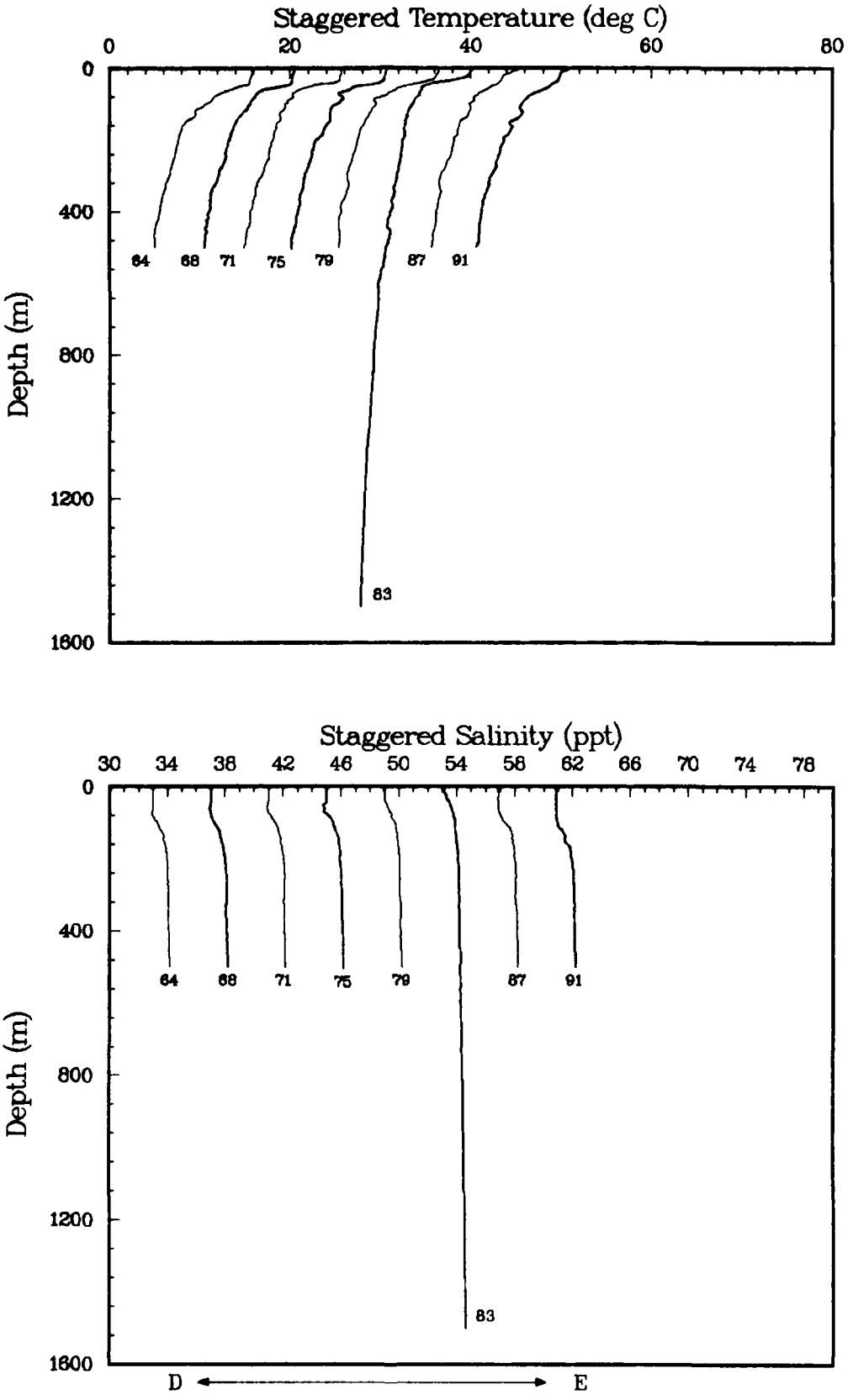

Staggered Temperature (deg C)
0
20
40
60
80
0
400
800
1200
1600
Depth (m)
64
68
71
75
79
87
91
83
Staggered Salinity (ppt)
30
34
38
42
46
50
54
58
62
66
70
74
78
0
400
800
1200
1600
Depth (m)
64
68
71
75
79
87
91
83
D
E

Figure 6(b).

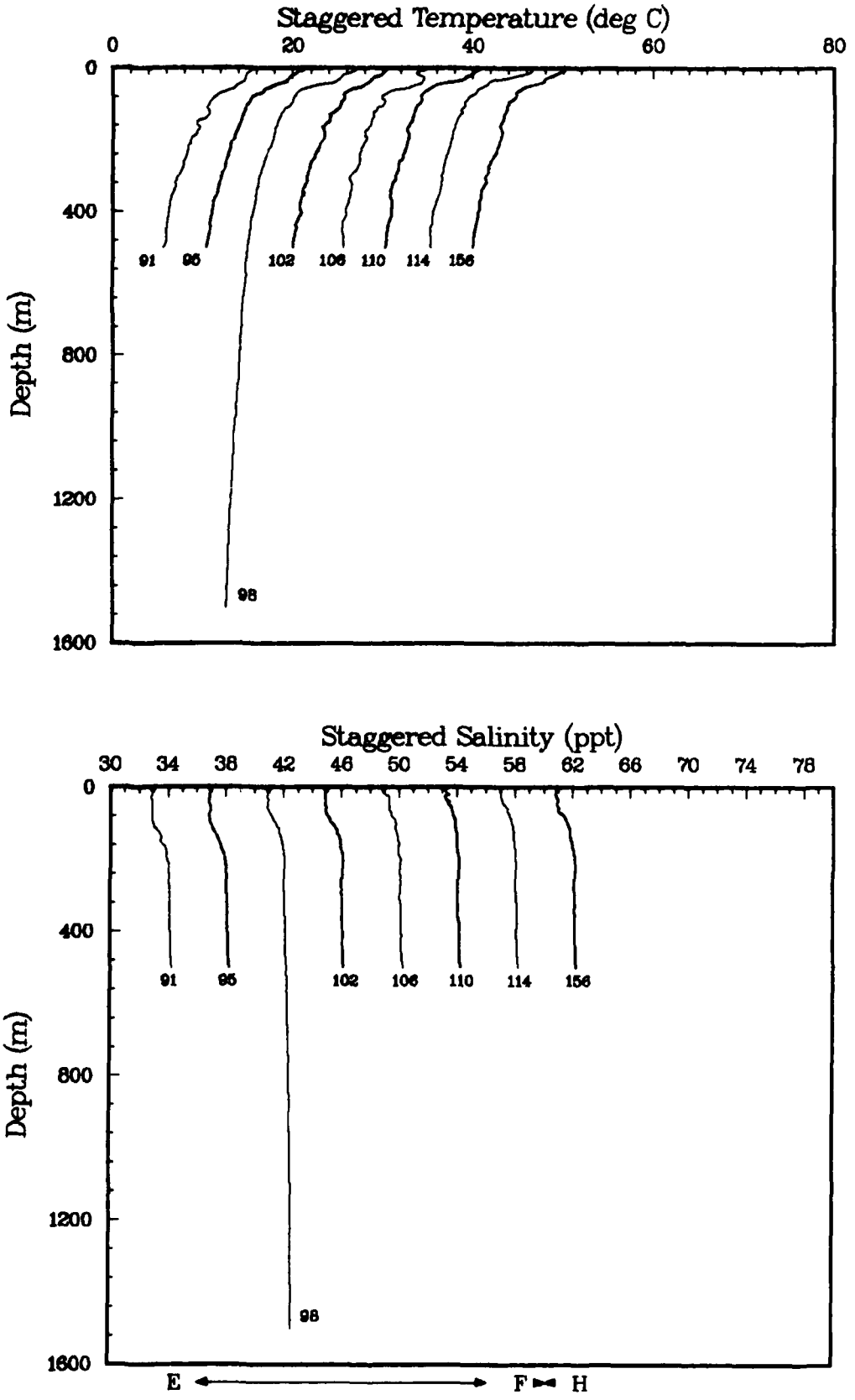

Staggered Temperature (deg C)
0
20
40
60
80
0
400
800
1200
1600
Depth (m)
91
95
102
106
110
114
156
98
Staggered Salinity (ppt)
30
34
38
42
46
50
54
58
62
66
70
74
78
0
400
800
1200
1600
Depth (m)
91
95
102
106
110
114
156
98
E
F
H

Figure 6(c).

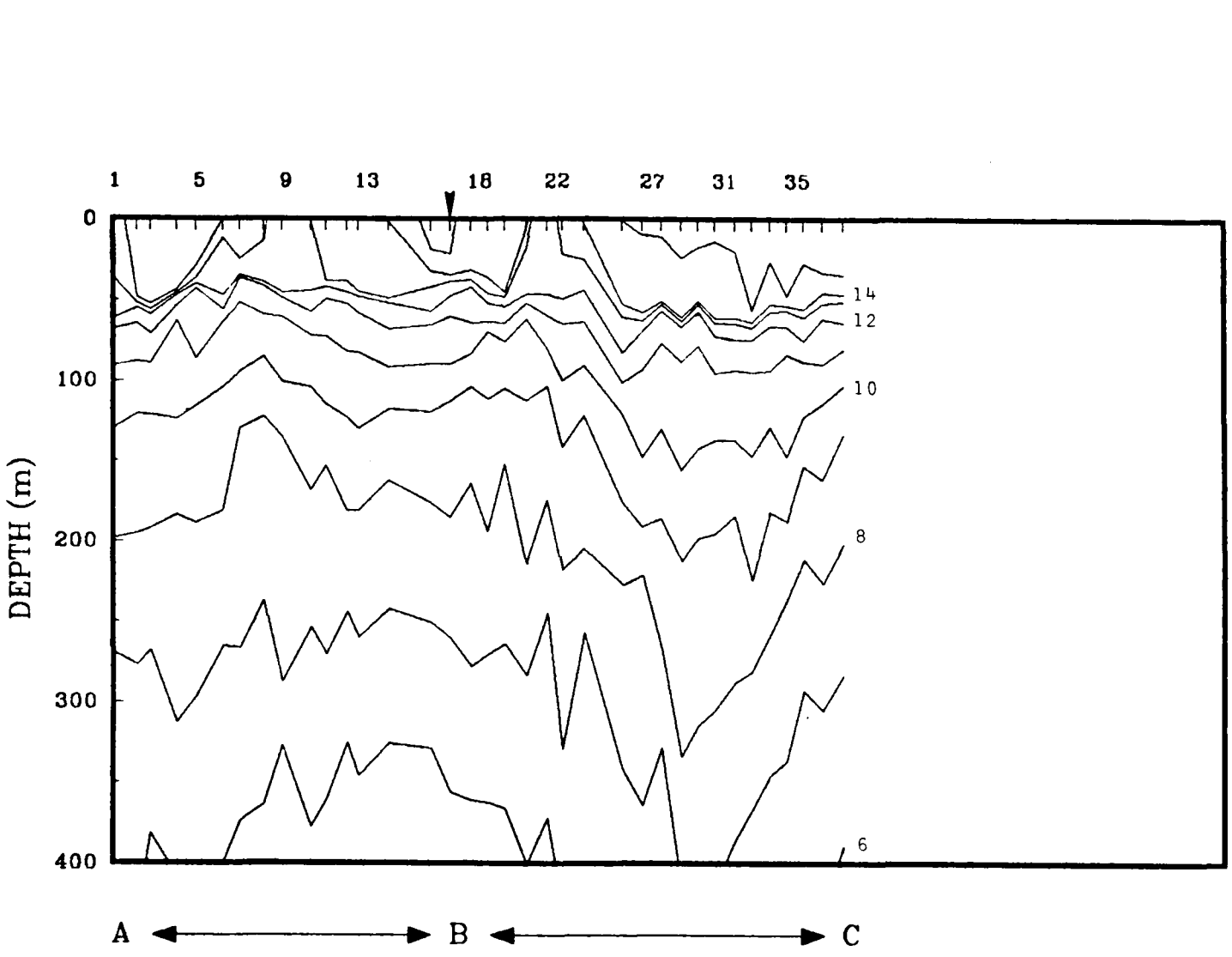


Figure 7(a): Isotherms from XBT's and CTD's. Tick marks along the horizontal axis show station positions. Some station numbers are shown. Arrows indicate the positions where the cruise track changed direction.

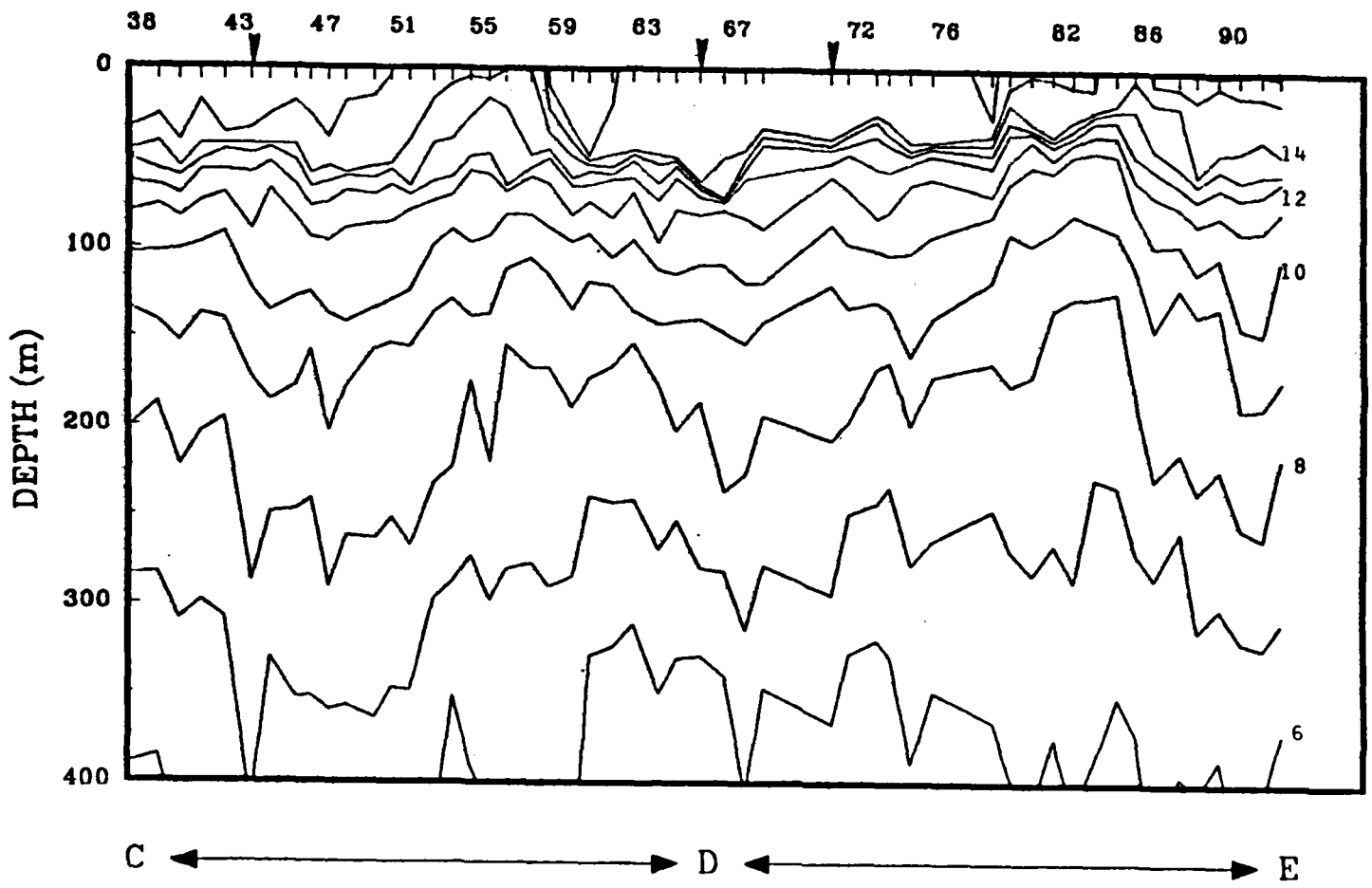

38
43
47
51
55
59
63
67
72
76
82
86
90
0
100
200
300
400
DEPTH (m)
14
12
10
8
6
C
D
E

Figure 7(b).

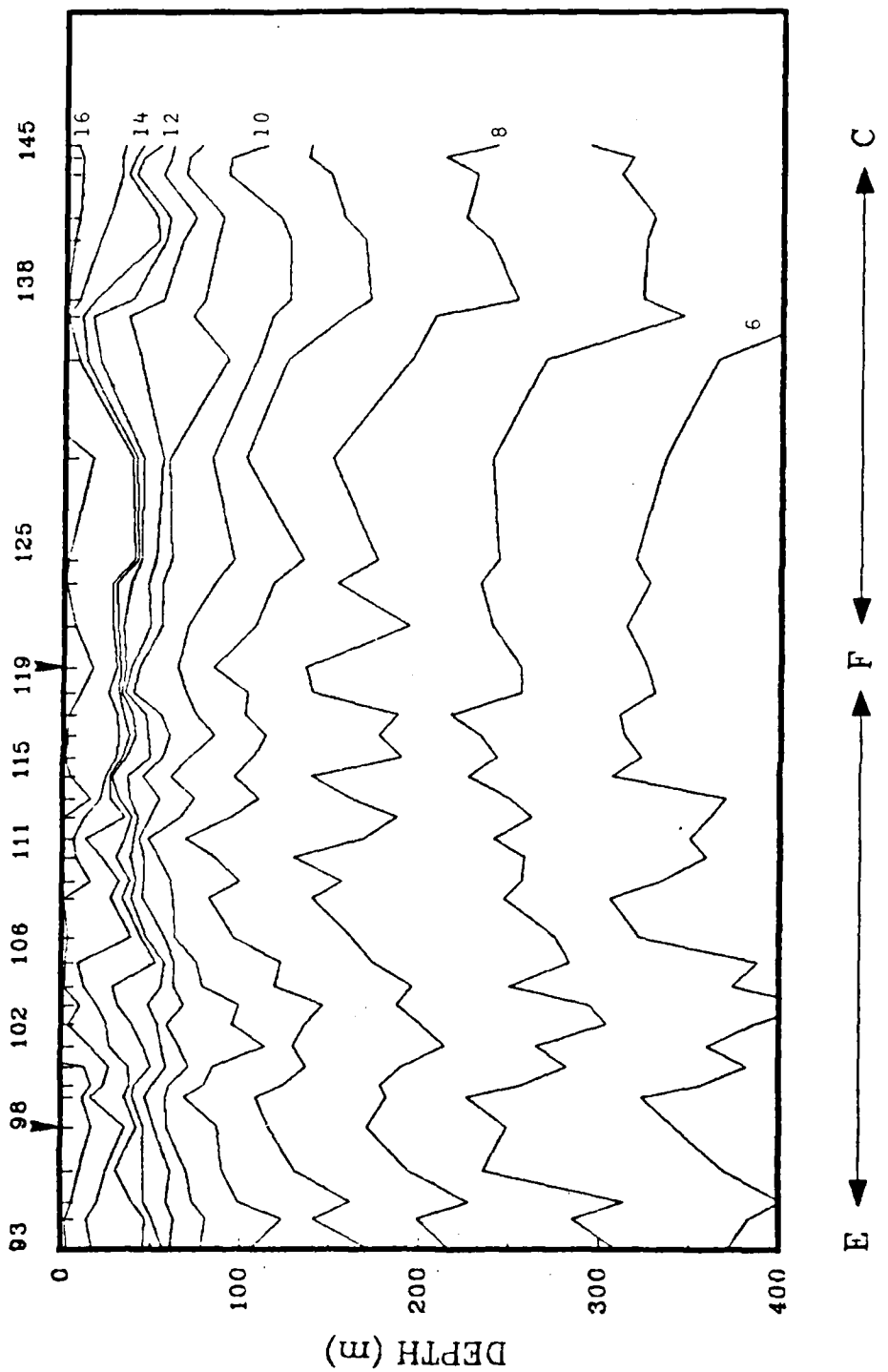

DEPTH (m)
0
100
200
300
400
93
98
102
106
111
115
119
125
138
145
16
14
12
10
8
6
E
F
C

Figure 7(c).

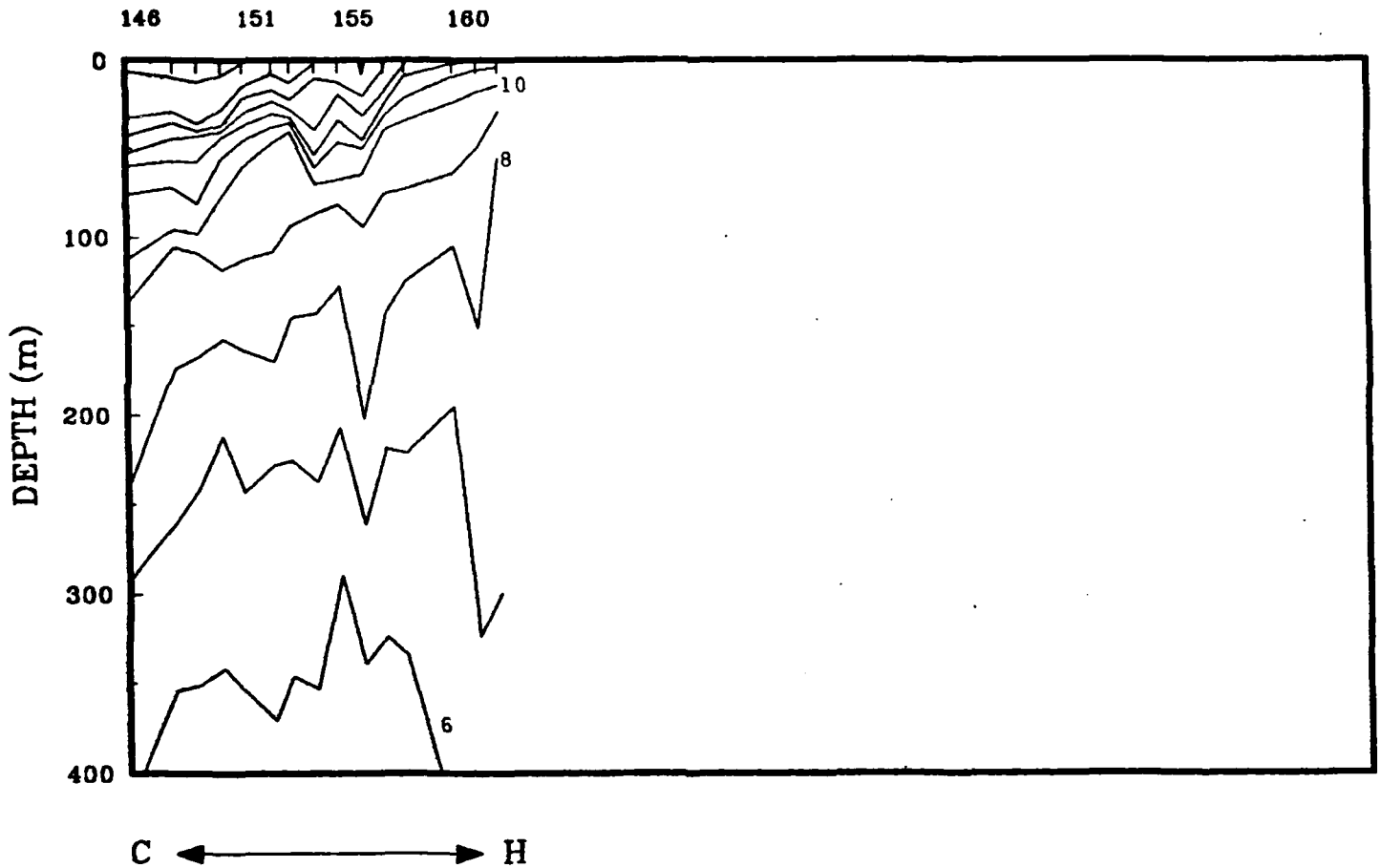


Figure 7(d).

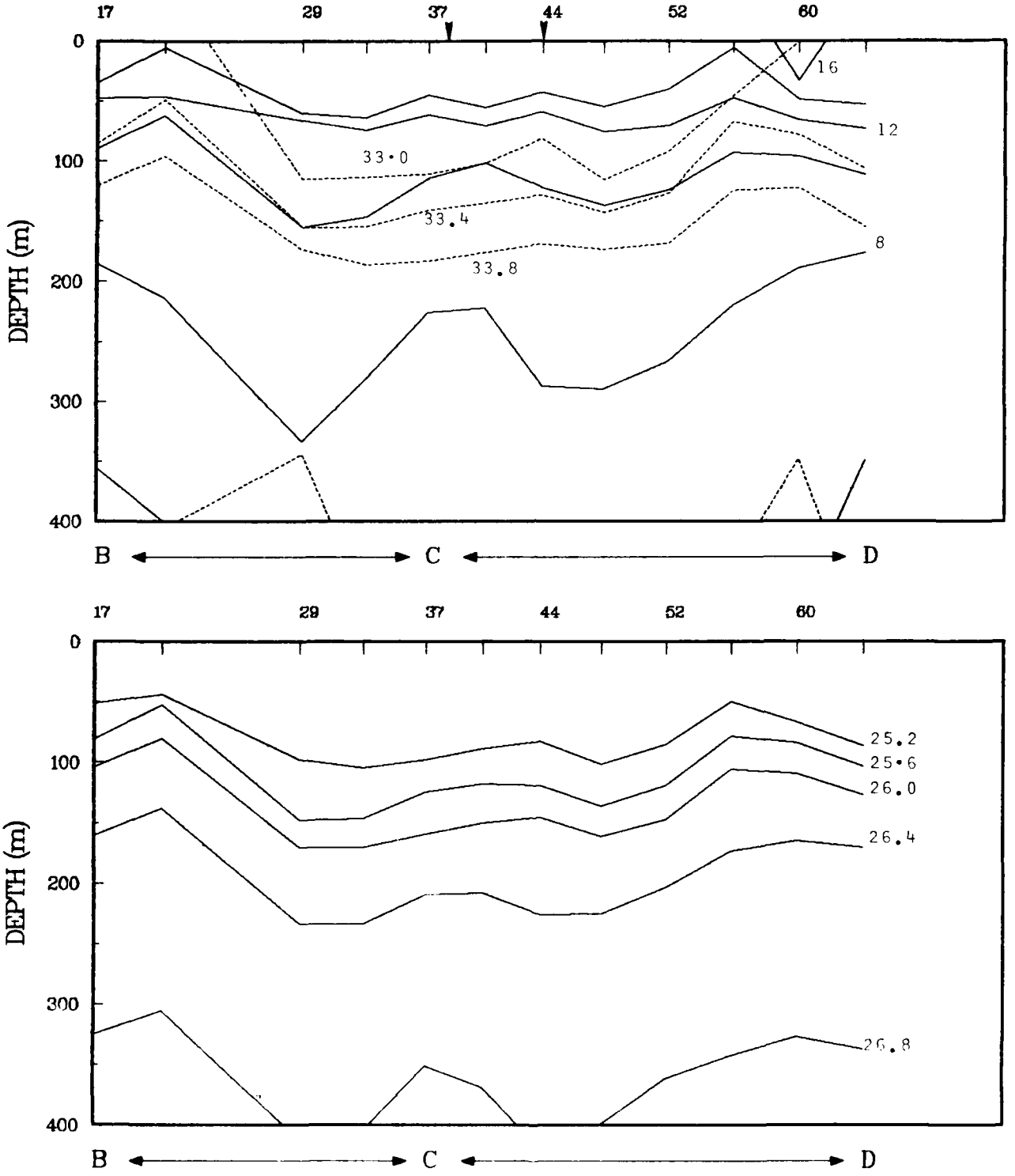


Figure 8(a): Isopleths of temperature, salinity and sigma-t, from the CTD's.

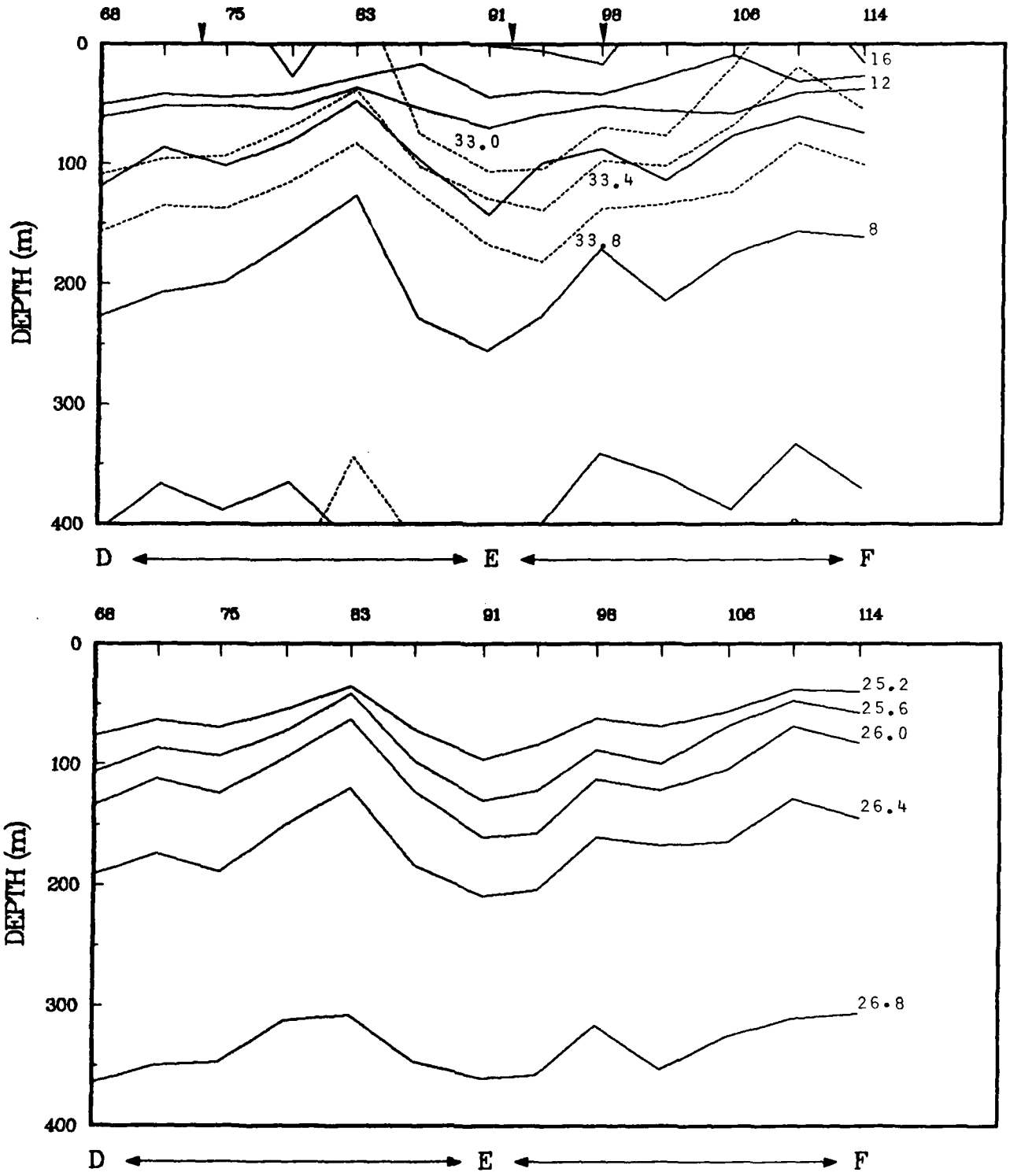

68
75
83
91
98
106
114
0
100
200
300
400
DEPTH (m)
16
12
33.0
33.4
33.8
8
D
E
F
25.2
25.6
26.0
26.4
26.8

Figure 8(b).

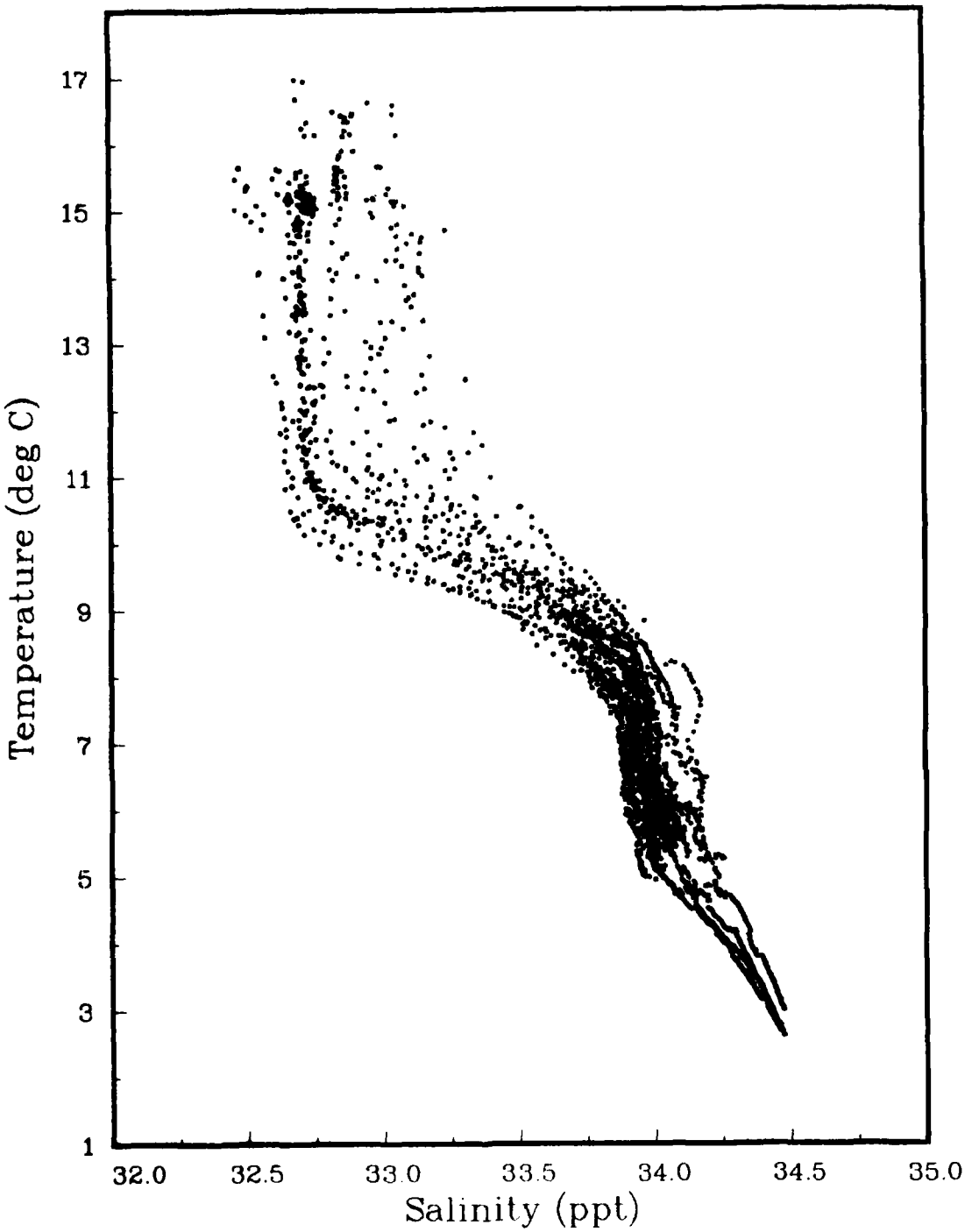


Figure 9: T-S pairs from the CTD casts for OPTOMA2, Leg 1.

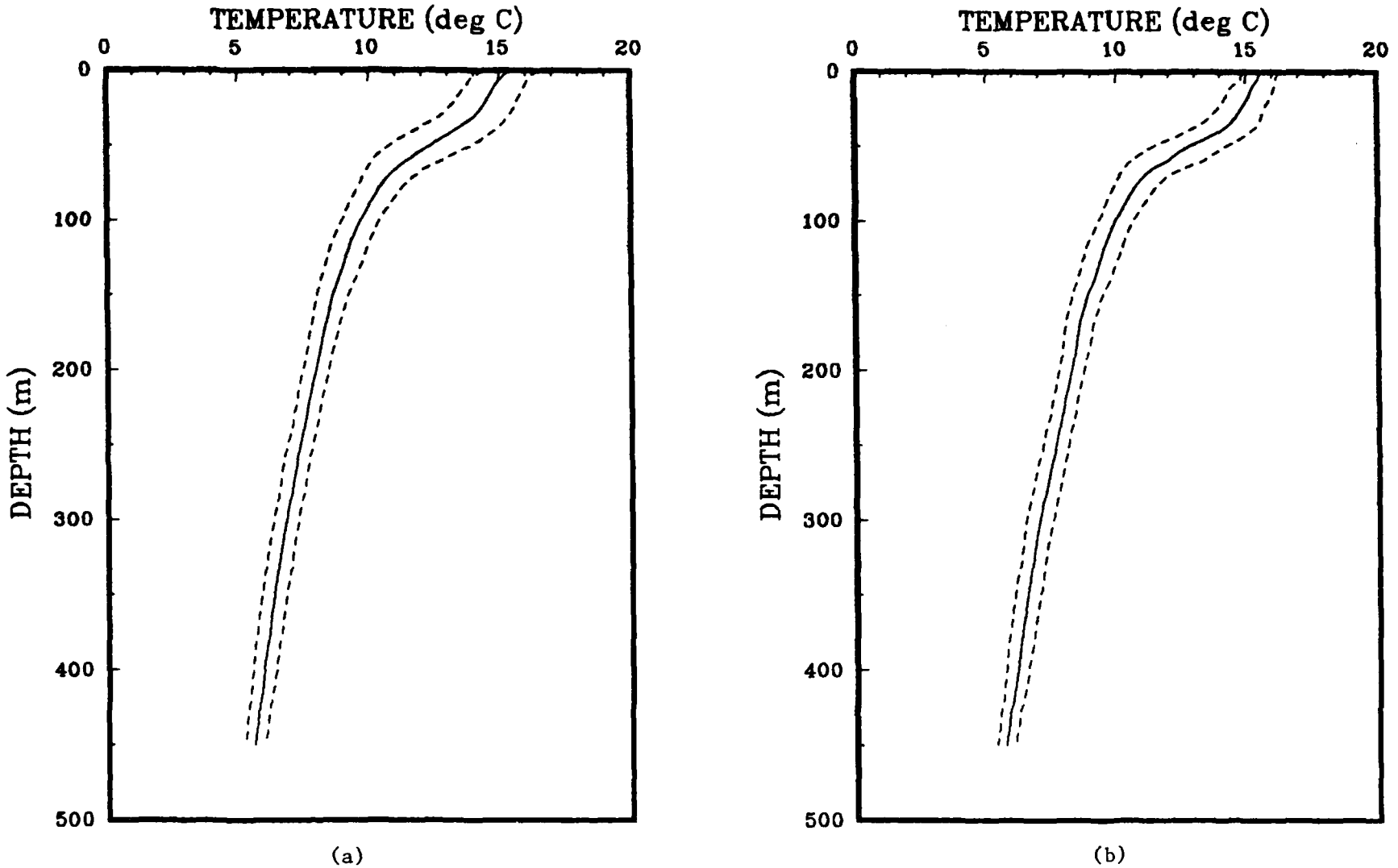


Figure 10: Profiles of $\overline{T(z)}$ with + and - the standard deviation from (a) XBT's and CTD's and (b) CTD's only.

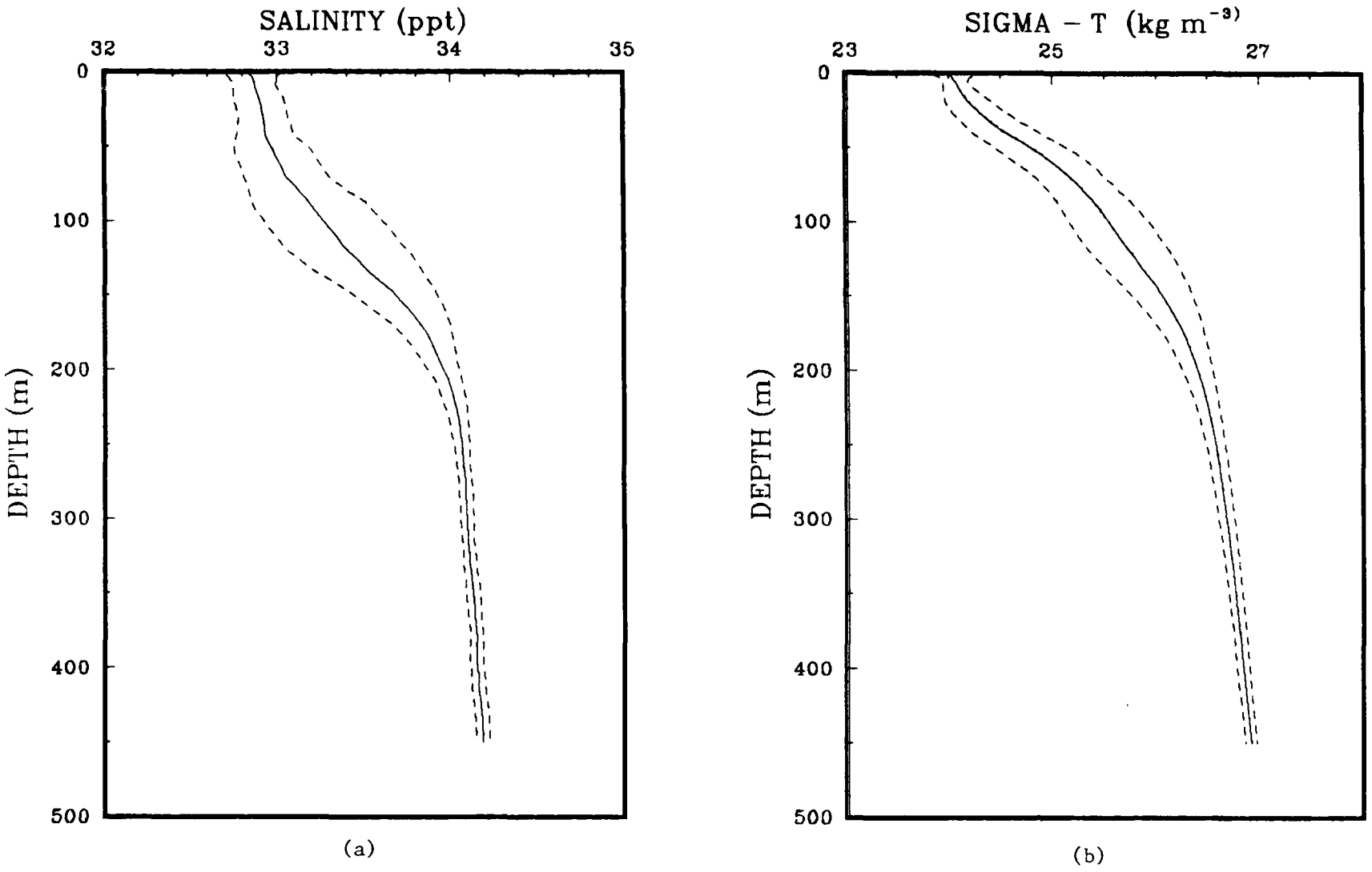


Figure 11: Profiles of (a) mean salinity and (b) mean sigma-t, with + and - the standard deviations, from the CTD's.

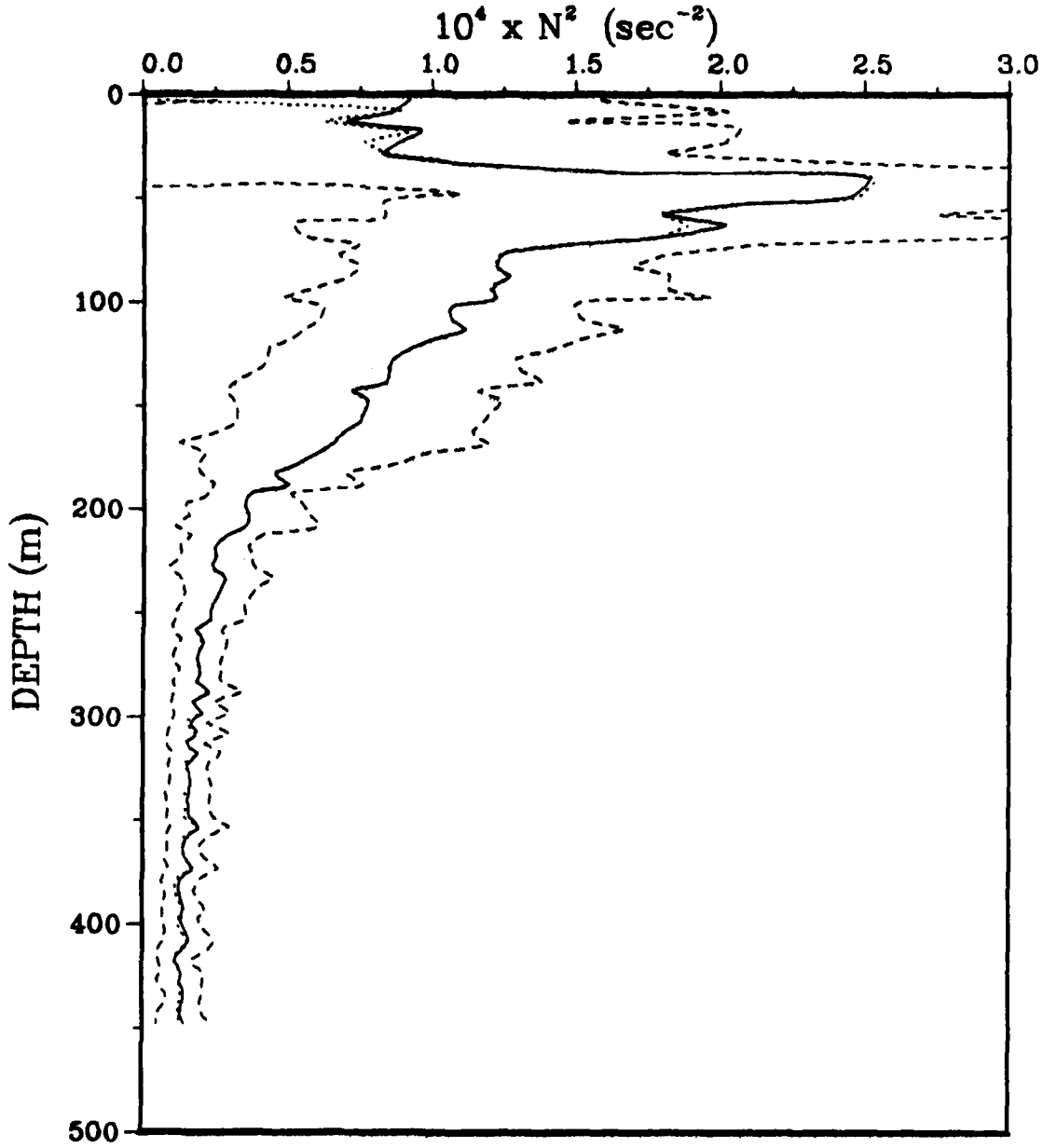


Figure 12: Profiles of $\overline{N^2(z)}$ (——), with + and - the standard deviation (----), and the profile of N^2 from $\overline{T(z)}$ and $\overline{S(z)}$ (.....).

SECTION 2

OPTOMA2 - LEG II

8 AUGUST to 14 AUGUST 1982

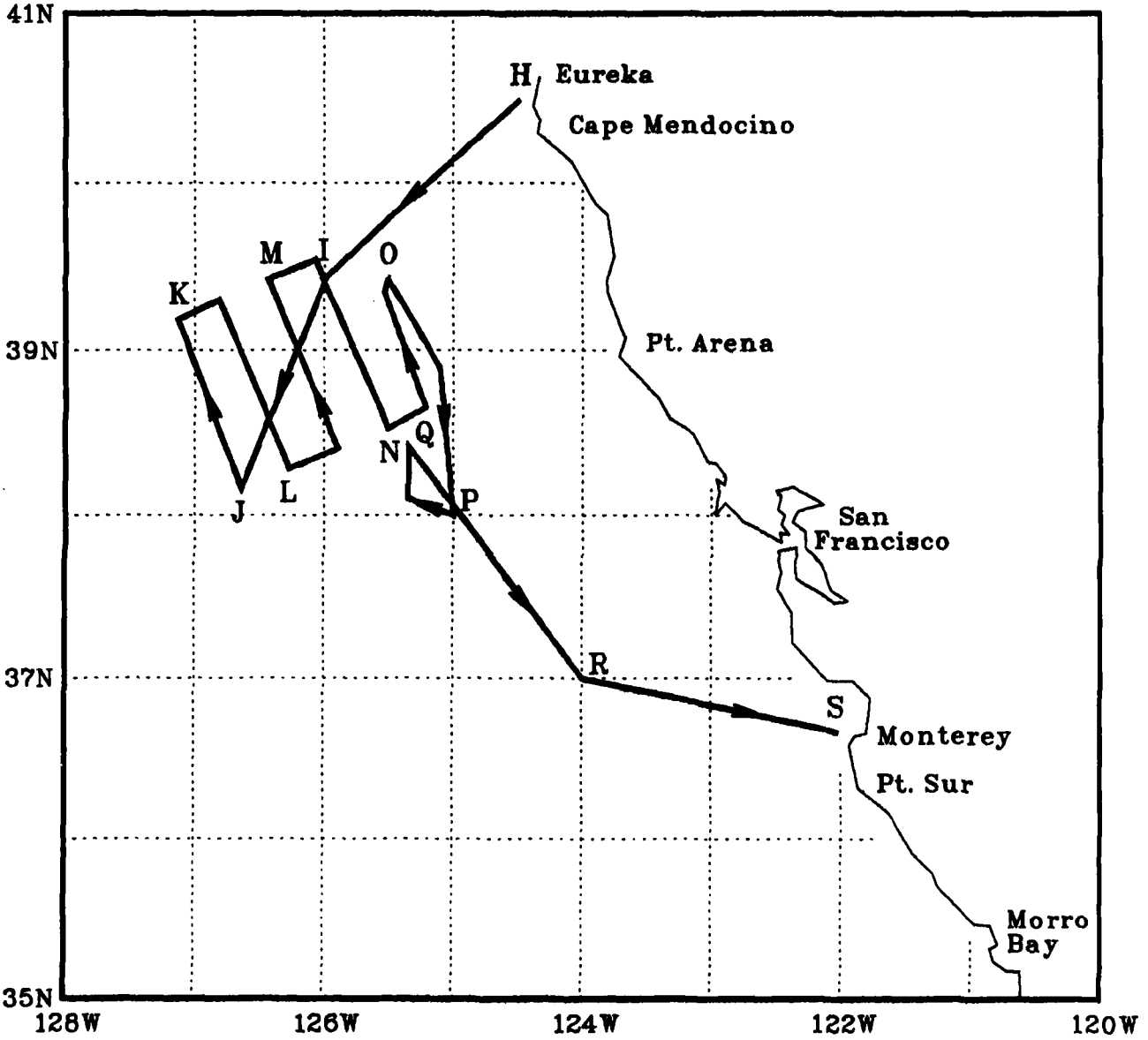


Figure 13: Cruise track for OPTOMA2, Leg II with transect extremes identified by letter.

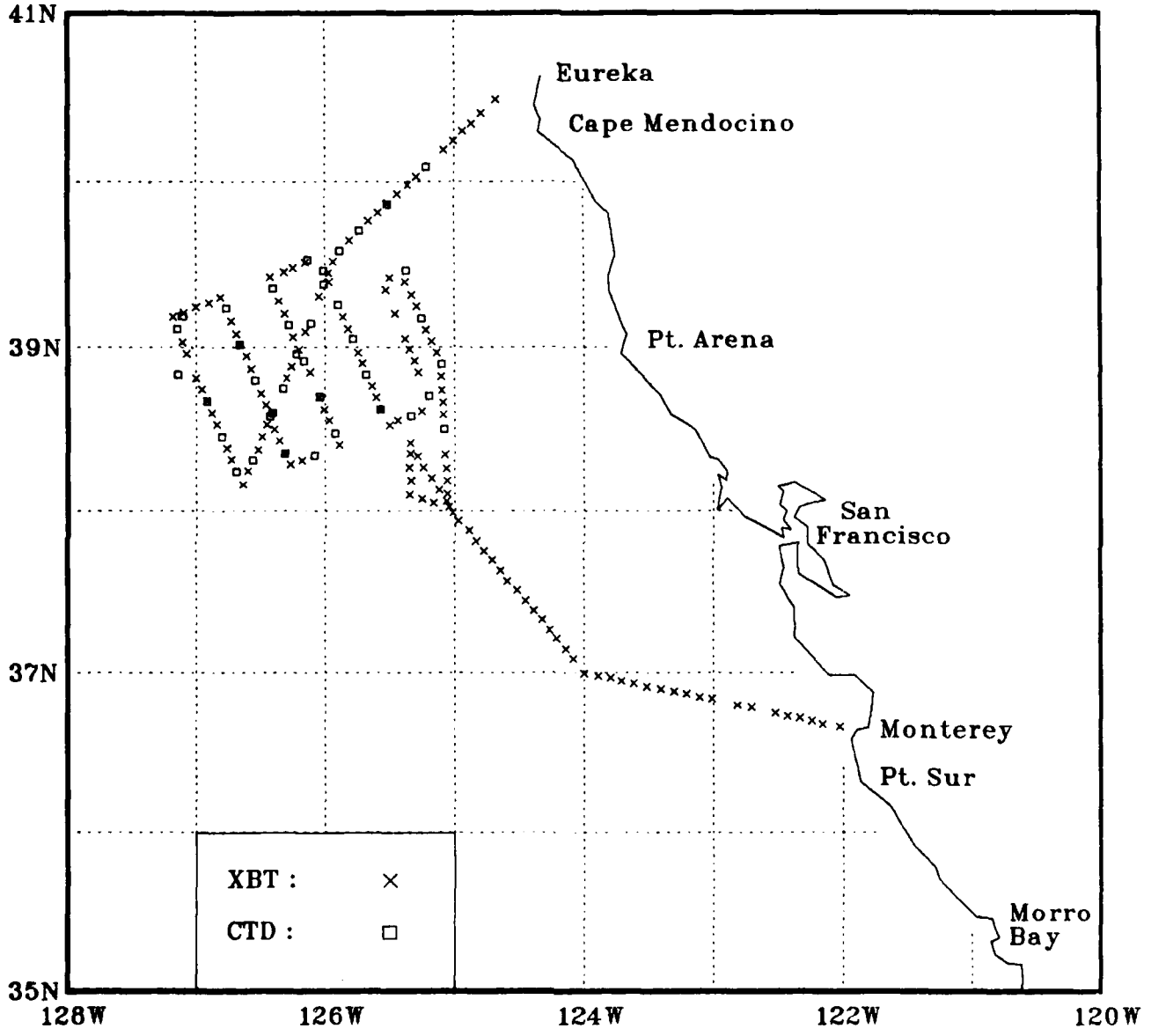


Figure 14: XBT and CTD locations for OPTOMA2, Leg II.

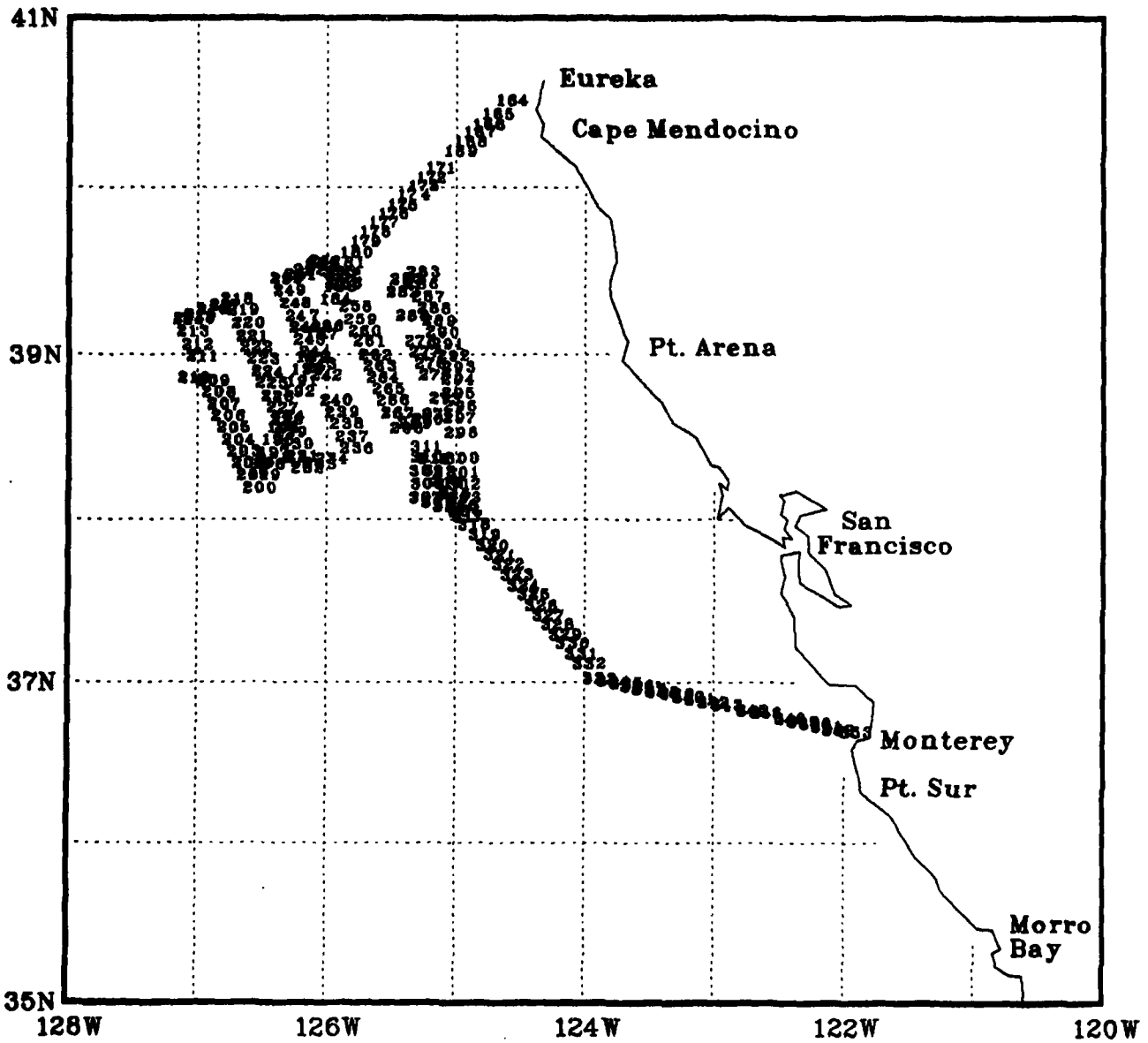


Figure 15: Station numbers for OPTOMA2, Leg II.

XBT - CTD STATION LISTING

STN	TYPE	YR/DAY	GMT	LAT (NORTH)	LONG (WEST)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
164	XBT	82220	1958	40.29	124.41	10.0			
165	XBT	82220	2043	40.24	124.47	11.8			
166	XBT	82220	2116	40.21	124.52	13.9			
167	XBT	82220	2143	40.18	124.56	14.2			
168	XBT	82220	2213	40.15	125.00	14.6			
169	XBT	82220	2242	40.11	125.05	14.4			
171	CTD	82220	2354	40.05	125.13	15.1	32.79	----	-----
172	XBT	82221	37	40.02	125.18	14.3			
173	XBT	82221	105	39.59	125.22	14.3			
174	XBT	82221	140	39.56	125.26	15.5			
175	XBT	82221	215	39.52	125.31	14.8			
175	CTD	82221	216	39.52	125.31	15.3	32.00	----	-----
176	XBT	82221	314	39.49	125.35	15.8			
177	XBT	82221	344	39.46	125.40	16.0			
178	CTD	82221	447	39.43	125.44	16.3	32.76	16.3	32.67
179	XBT	82221	529	39.39	125.48	16.5			
180	CTD	82221	638	39.35	125.53	16.6	32.77	16.6	32.70
181	XBT	82221	744	39.31	125.56	16.6			
182	XBT	82221	823	39.27	125.58	16.4			
183	CTD	82221	905	39.23	126.01	16.3	32.86	16.4	32.66
184	XBT	82221	947	39.18	126.02	16.1			
186	CTD	82221	1127	39.09	126.07	15.8	32.87	15.8	32.81
187	XBT	82221	1226	39.06	126.09	15.7			
189	CTD	82221	1342	38.58	126.14	15.6	32.77	15.7	32.94
190	XBT	82221	1432	38.53	126.16	15.2			
191	XBT	82221	1507	38.49	126.18	16.2			
192	CTD	82221	1608	38.45	126.19	16.5	33.03	----	32.98
194	XBT	82221	1832	38.36	126.24	16.8			
194	CTD	82221	1808	38.36	126.25	16.6	33.04	----	32.99
195	XBT	82221	1906	38.32	126.27	16.8			
196	XBT	82221	1939	38.27	126.29	16.7			
197	XBT	82221	2015	38.23	126.31	16.8			
198	CTD	82221	2116	38.19	126.34	25.6	0.0	16.6	32.98
199	XBT	82221	2217	38.15	126.36	16.7			
200	XBT	82221	2252	38.10	126.38	16.7			
201	CTD	82221	2342	38.14	126.41	16.9	33.07	17.0	33.01
202	XBT	82222	30	38.19	126.43	16.8			
203	XBT	82222	101	38.23	126.46	16.7			
204	CTD	82222	134	38.27	126.48	16.2	33.23	16.5	33.07
205	XBT	82222	239	38.32	126.51	16.8			
206	XBT	82222	314	38.36	126.53	16.9			
207	XBT	82222	349	38.40	126.55	16.2			
207	CTD	82222	404	38.40	126.55	16.3	33.14	16.4	33.12
208	XBT	82222	457	38.45	126.57	16.6			
209	XBT	82222	533	38.49	126.60	16.8			
210	CTD	82222	618	38.50	127.08	16.4	33.18	16.5	33.19
211	XBT	82222	707	38.58	127.04	16.8			
212	XBT	82222	737	39.02	127.07	16.8			

STN	TYPE	YR/DAY	GMT	LAT (NORTH)	LONG (WEST)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
213	CTD	82222	823	39.07	127.09	16.0	32.83	16.1	32.61
214	XBT	82222	910	39.11	127.11	15.9			
215	XBT	82222	942	39.13	127.06	14.9			
216	XBT	82222	1016	39.15	127.00	16.2			
216	CTD	82222	1018	39.11	127.06	15.5	32.84	15.6	-----
217	XBT	82222	1204	39.16	126.54	15.8			
218	XBT	82222	1237	39.18	126.49	15.7			
219	CTD	82222	1322	39.14	126.46	15.6	32.78	16.6	32.80
220	XBT	82222	1408	39.10	126.43	16.4			
221	XBT	82222	1443	39.05	126.41	16.7			
222	XBT	82222	1515	39.01	126.40	16.7			
222	CTD	82222	1530	39.01	126.40	16.5	33.04	16.5	32.98
223	XBT	82222	1615	38.57	126.37	16.4			
224	XBT	82222	1652	38.52	126.35	16.9			
225	CTD	82222	1740	38.48	126.32	16.7	33.02	16.8	33.00
226	XBT	82222	1829	38.43	126.30	16.6			
227	XBT	82222	1859	38.39	126.27	15.8			
228	CTD	82222	1941	38.35	126.25	15.5	32.75	15.8	32.71
229	XBT	82222	2023	38.30	126.24	16.1			
230	XBT	82222	2054	38.26	126.21	16.0			
231	XBT	82222	2123	38.21	126.19	16.0			
231	CTD	82222	2137	38.21	126.19	15.7	32.77	15.7	32.79
232	XBT	82222	2220	38.17	126.16	16.4			
233	XBT	82222	2251	38.19	126.11	16.0			
234	CTD	82222	2340	38.21	126.05	15.8	32.81	15.9	32.78
236	XBT	82223	100	38.24	125.53	16.0			
237	CTD	82223	145	38.29	125.56	16.3	32.73	16.4	32.71
238	XBT	82223	230	38.33	125.58	16.4			
239	XBT	82223	300	38.37	126.00	16.5			
240	XBT	82223	333	38.42	126.02	16.2			
240	CTD	82223	348	38.42	126.02	16.2	32.77	16.7	32.73
242	XBT	82223	504	38.51	126.07	16.7			
243	CTD	82223	549	38.55	126.10	16.5	32.62	16.4	32.75
244	XBT	82223	635	38.59	126.12	16.6			
245	XBT	82223	708	39.04	126.15	16.2			
246	CTD	82223	753	39.08	126.17	16.2	32.67	16.3	-----
247	XBT	82223	834	39.12	126.19	16.2			
248	XBT	82223	906	39.17	126.21	16.1			
249	CTD	82223	952	39.21	126.24	16.1	32.72	16.2	32.68
250	XBT	82223	1031	39.26	126.26	16.3			
251	XBT	82223	1104	39.27	126.19	16.5			
252	XBT	82223	1137	39.29	126.15	16.5			
252	CTD	82223	1149	39.32	126.08	16.4	32.84	16.4	32.80
253	XBT	82223	1232	39.31	126.09	16.5			
255	CTD	82223	1347	39.28	126.01	16.5	32.82	16.5	32.78
256	XBT	82223	1428	39.24	125.58	16.5			
258	CTD	82223	1538	39.16	125.54	16.2	32.64	16.2	-----
259	XBT	82223	1622	39.11	125.52	16.3			
260	XBT	82223	1652	39.07	125.49	16.3			

STN	TYPE	YR/DAY	GMT	LAT (NORTH)	LONG (WEST)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
261	CTD	82223	1731	39.03	125.47	16.2	32.79	16.3	32.76
262	XBT	82223	1820	38.58	125.45	16.9			
263	XBT	82223	1848	38.54	125.43	16.7			
264	CTD	82223	1929	38.50	125.41	16.2	32.87	16.4	32.87
265	XBT	82223	2012	38.46	125.38	16.5			
266	XBT	82223	2042	38.42	125.36	16.9			
267	XBT	82223	2117	38.37	125.34	16.8			
267	CTD	82223	2146	38.37	125.34	16.7	32.79	16.8	32.88
268	XBT	82223	2308	38.32	125.30	16.2			
269	XBT	82223	2339	38.33	125.26	16.9			
270	CTD	82224	26	38.35	125.20	16.8	32.76	16.9	32.71
271	XBT	82224	117	38.37	125.15	16.8			
273	CTD	82224	252	38.42	125.12	16.7	32.85	16.8	32.78
275	XBT	82224	505	38.51	125.17	16.2			
276	XBT	82224	558	38.55	125.19	16.2			
277	XBT	82224	708	38.59	125.21	16.9			
278	XBT	82224	815	39.03	125.23	16.6			
280	XBT	82224	1101	39.12	125.28	16.9			
282	XBT	82224	1428	39.21	125.32	16.5			
283	XBT	82224	1601	39.25	125.30	16.5			
283	CTD	82224	1805	39.28	125.22	16.8	32.84	----	-----
286	XBT	82224	1839	39.24	125.23	16.8			
287	XBT	82224	1909	39.19	125.20	16.7			
288	XBT	82224	1941	39.15	125.17	17.0			
289	CTD	82224	2023	39.11	125.15	16.5	32.86	16.6	32.82
290	XBT	82224	2101	39.06	125.13	16.5			
291	XBT	82224	2128	39.02	125.11	16.6			
292	XBT	82224	2155	38.58	125.08	16.6			
293	CTD	82224	2244	38.54	125.06	16.7	32.84	16.8	32.77
294	XBT	82224	2328	38.50	125.06	16.6			
295	XBT	82225	5	38.45	125.06	16.8			
296	XBT	82225	40	38.40	125.05	16.6			
297	XBT	82225	111	38.35	125.05	16.4			
300	XBT	82225	322	38.21	125.04	16.3			
301	XBT	82225	400	38.16	125.04	13.9			
302	XBT	82225	459	38.11	125.03	14.1			
303	XBT	82225	533	38.06	125.03	15.5			
304	XBT	82225	606	38.01	125.03	15.5			
305	XBT	82225	659	38.03	125.10	15.0			
306	XBT	82225	742	38.05	125.15	14.9			
307	XBT	82225	822	38.06	125.21	14.9			
308	XBT	82225	908	38.11	125.20	14.5			
309	XBT	82225	1004	38.16	125.21	15.1			
310	XBT	82225	1109	38.21	125.21	16.2			
311	XBT	82225	1204	38.25	125.21	16.3			
312	XBT	82225	1251	38.20	125.17	16.0			
313	XBT	82225	1336	38.16	125.15	14.8			
314	XBT	82225	1419	38.12	125.11	14.0			
315	XBT	82225	1501	38.08	125.07	14.5			

STN	TYPE	YR/DAY	GMT	LAT (NORTH)	LONG (WEST)	SURFACE TEMP (DEG C)	SURFACE SALINITY (PPT)	BUCKET TEMP (DEG C)	BOTTLE SALINITY (PPT)
316	XBT	82225	1531	38.04	125.04	14.8			
317	XBT	82225	1601	37.60	125.01	15.8			
318	XBT	82225	1624	37.57	124.58	16.4			
319	XBT	82225	1658	37.53	124.54	16.1			
320	XBT	82225	1728	37.49	124.50	15.4			
321	XBT	82225	1758	37.45	124.46	14.7			
322	XBT	82225	1827	37.42	124.42	13.9			
323	XBT	82225	1857	37.38	124.38	15.4			
324	XBT	82225	1928	37.34	124.35	16.4			
325	XBT	82225	2000	37.31	124.31	15.8			
326	XBT	82225	2034	37.27	124.27	15.9			
327	XBT	82225	2106	37.23	124.23	15.9			
328	XBT	82225	2136	37.20	124.19	16.0			
329	XBT	82225	2205	37.16	124.16	15.0			
330	XBT	82225	2239	37.13	124.13	15.0			
331	XBT	82225	2313	37.09	124.09	15.0			
332	XBT	82225	2343	37.05	124.05	14.5			
333	XBT	82226	26	36.60	124.00	15.1			
334	XBT	82226	59	36.59	123.54	15.5			
335	XBT	82226	131	36.58	123.48	15.3			
336	XBT	82226	200	36.57	123.43	15.1			
337	XBT	82226	227	36.56	123.37	15.2			
338	XBT	82226	258	36.55	123.31	15.6			
339	XBT	82226	332	36.54	123.24	15.4			
340	XBT	82226	402	36.53	123.18	15.5			
341	XBT	82226	431	36.52	123.13	15.4			
342	XBT	82226	503	36.51	123.07	15.3			
343	XBT	82226	534	36.50	123.01	14.9			
345	XBT	82226	638	36.48	122.49	14.9			
346	XBT	82226	711	36.47	122.43	14.3			
348	XBT	82226	813	36.45	122.32	13.6			
349	XBT	82226	846	36.44	122.26	13.3			
350	XBT	82226	916	36.43	122.20	13.1			
351	XBT	82226	948	36.42	122.14	13.6			
352	XBT	82226	1019	36.41	122.09	13.9			
353	XBT	82226	1104	36.40	122.01	12.9			

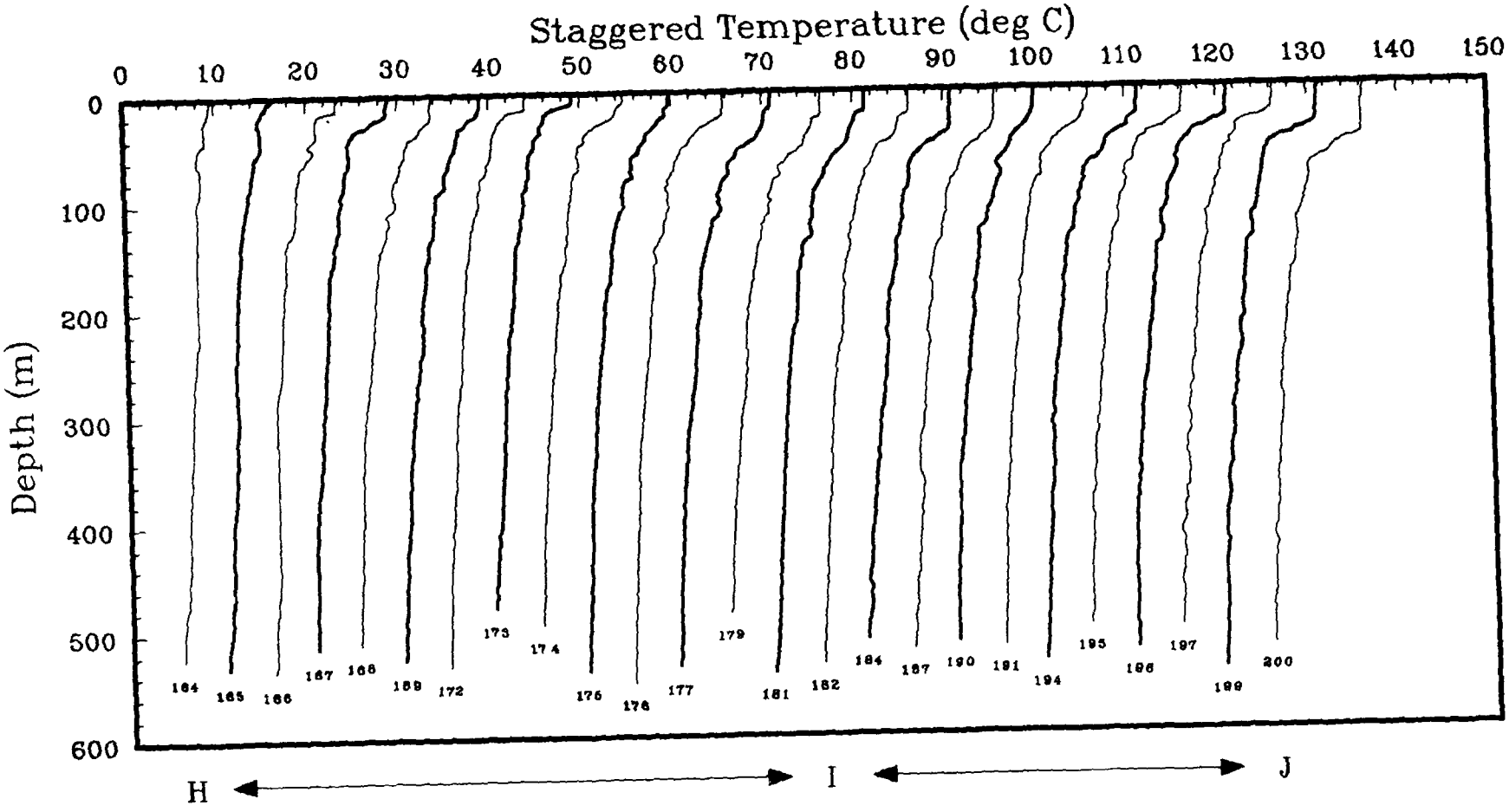


Figure 16(a): Staggered temperature profiles from the XBT's. Profiles are staggered by a multiple of 5C.

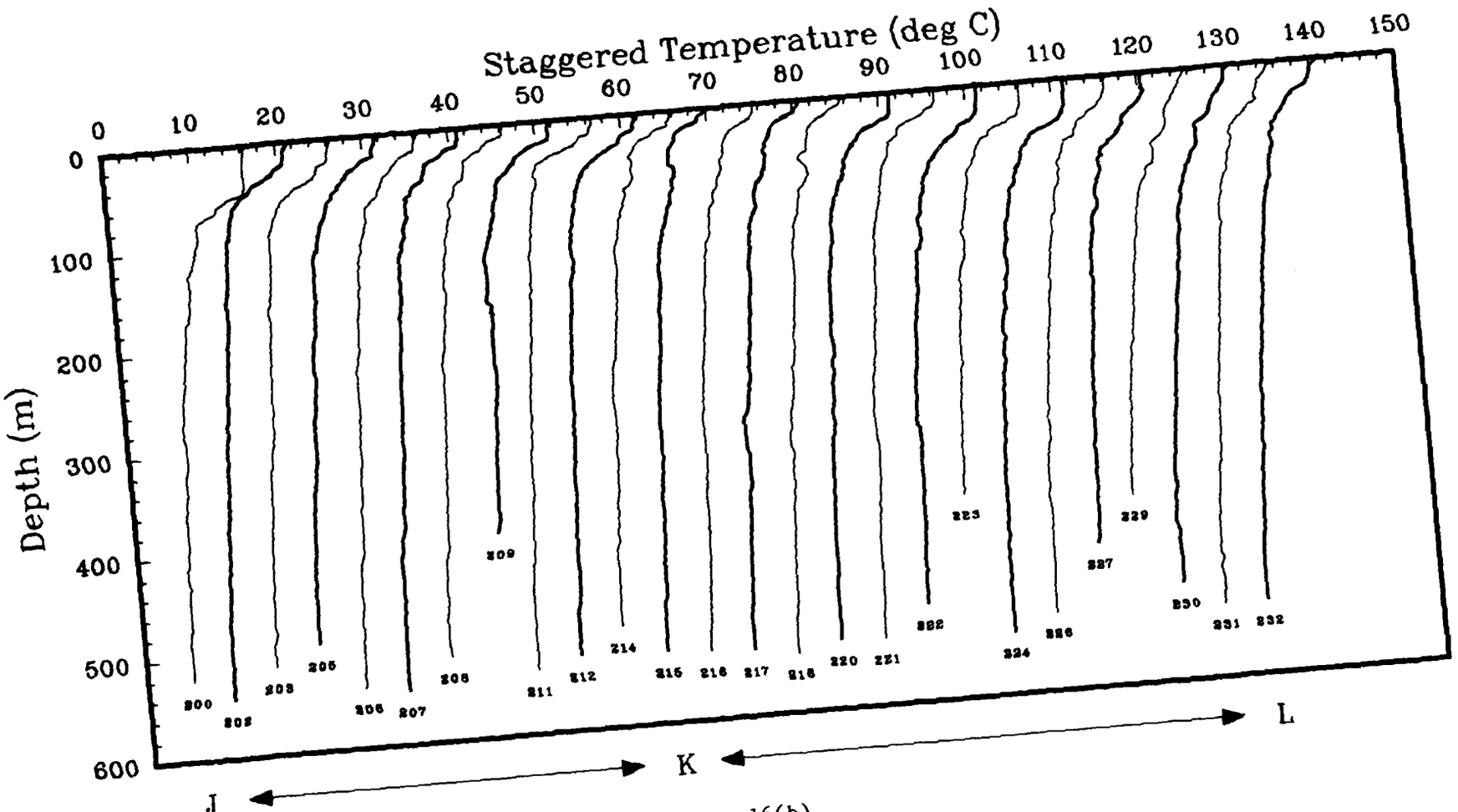

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
200
202
203
205
206
207
208
209
211
212
214
215
216
217
218
220
221
222
223
224
226
227
229
230
231
232
J
K
L

Figure 16(b).

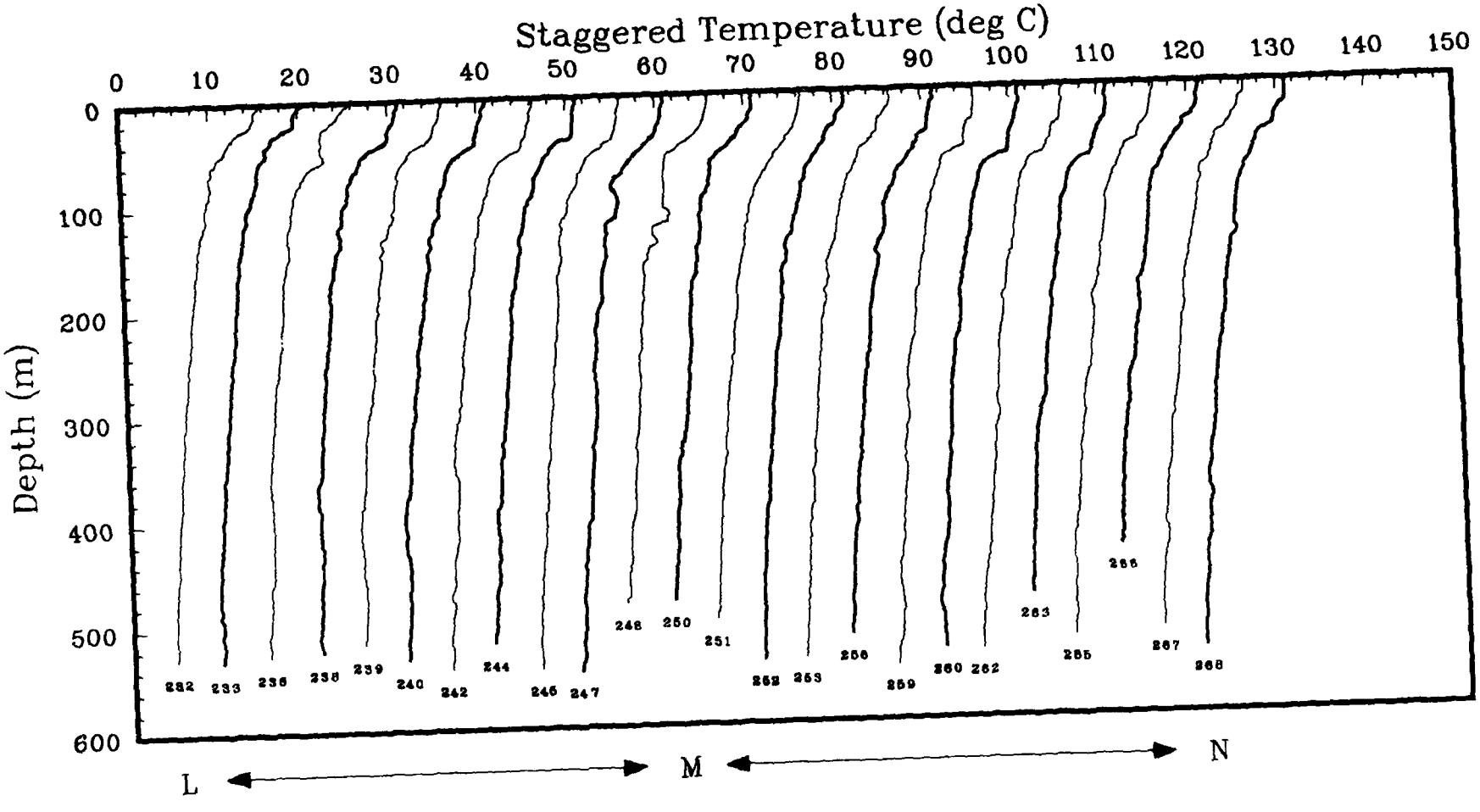

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
232
233
236
238
239
240
242
244
246
247
248
250
251
252
253
256
259
260
262
263
265
266
267
268
L
M
N

Figure 16(c).

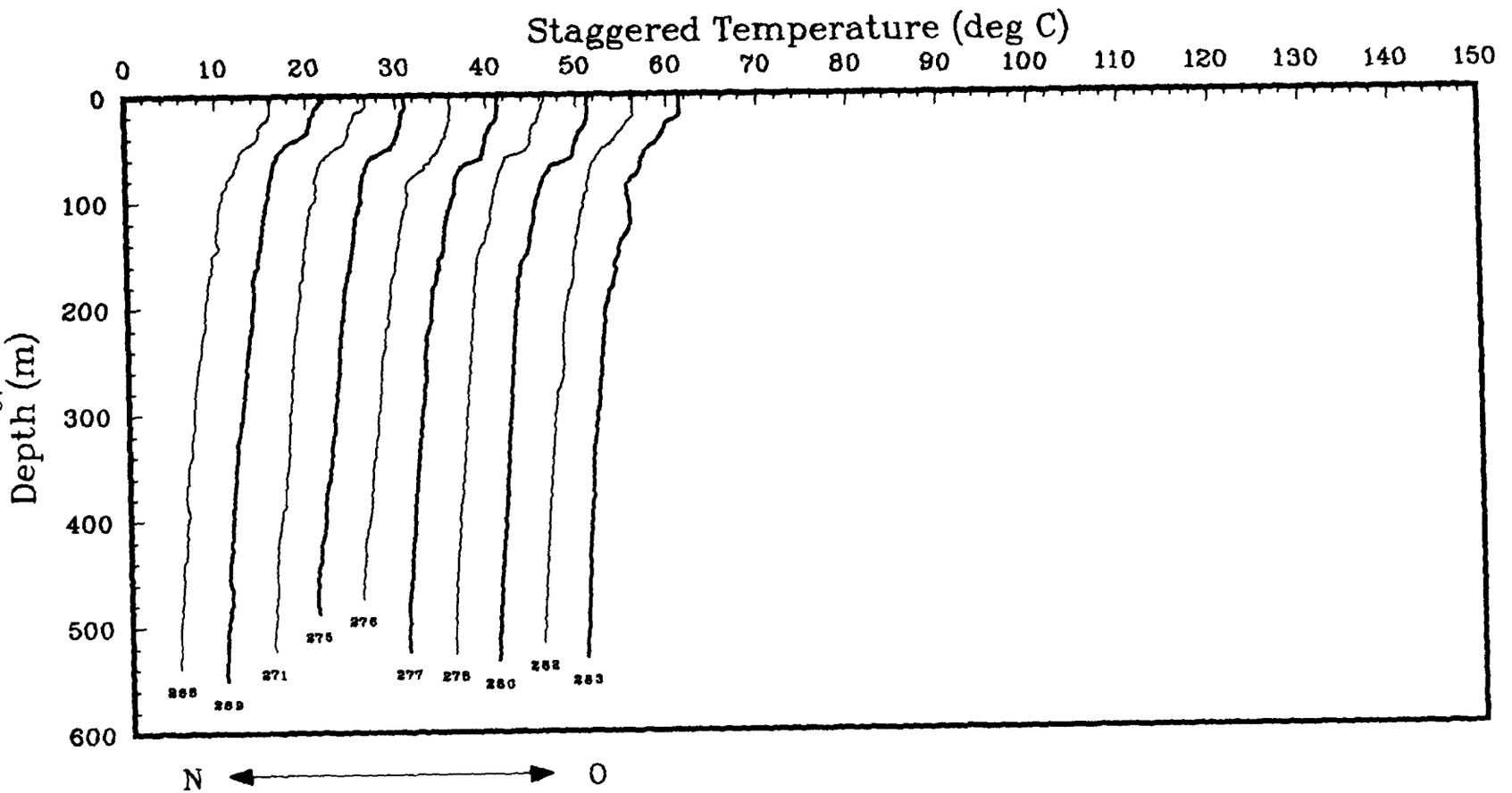

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
268
269
271
275
276
277
278
280
282
283
N
O

Figure 16(d).

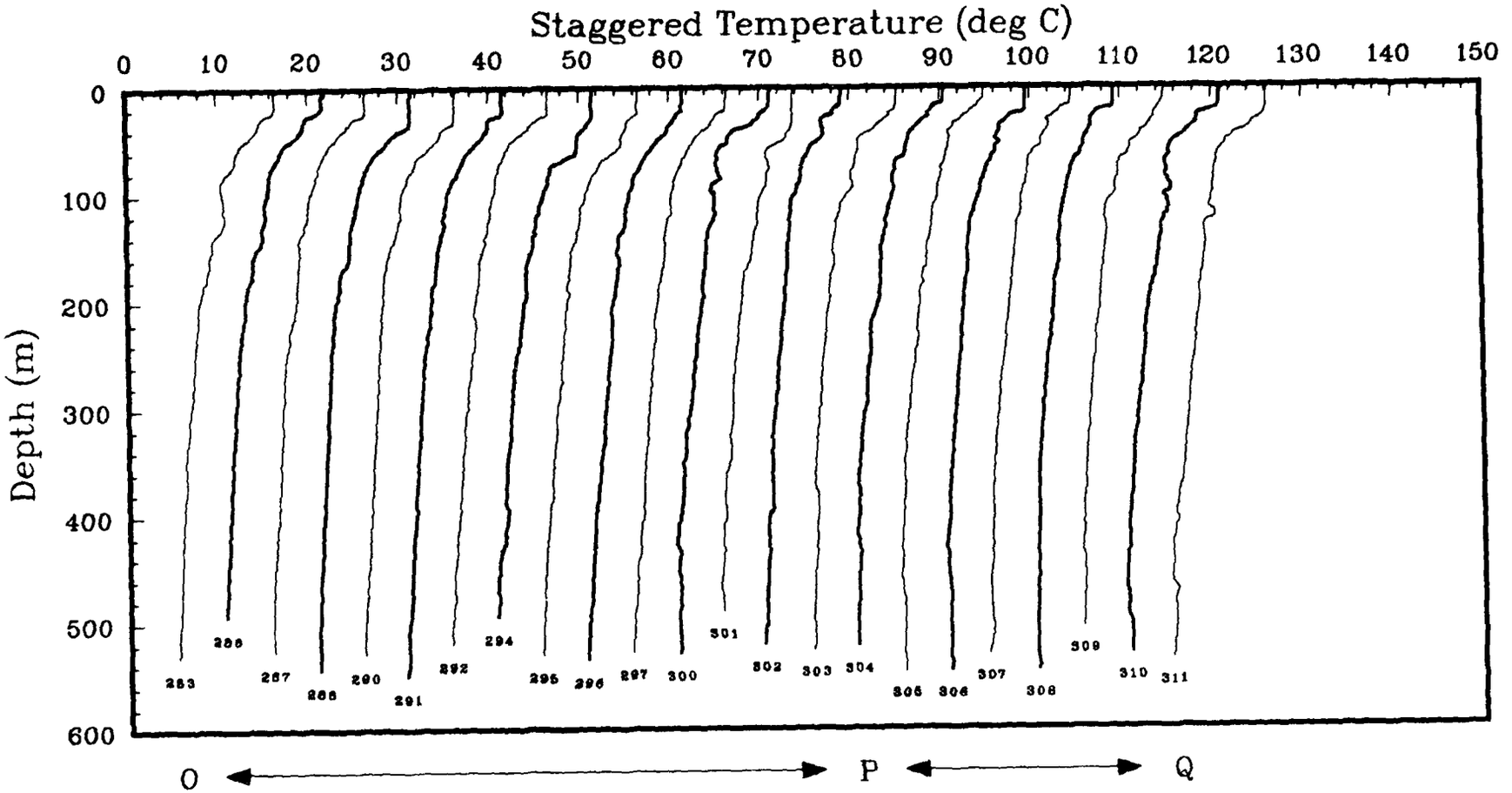

Staggered Temperature (deg C)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Depth (m)
0 100 200 300 400 500 600
283 286 287 288 290 291 292 294 295 296 297 300 301 302 303 304 305 306 307 308 309 310 311
O
P
Q

Figure 16(e).

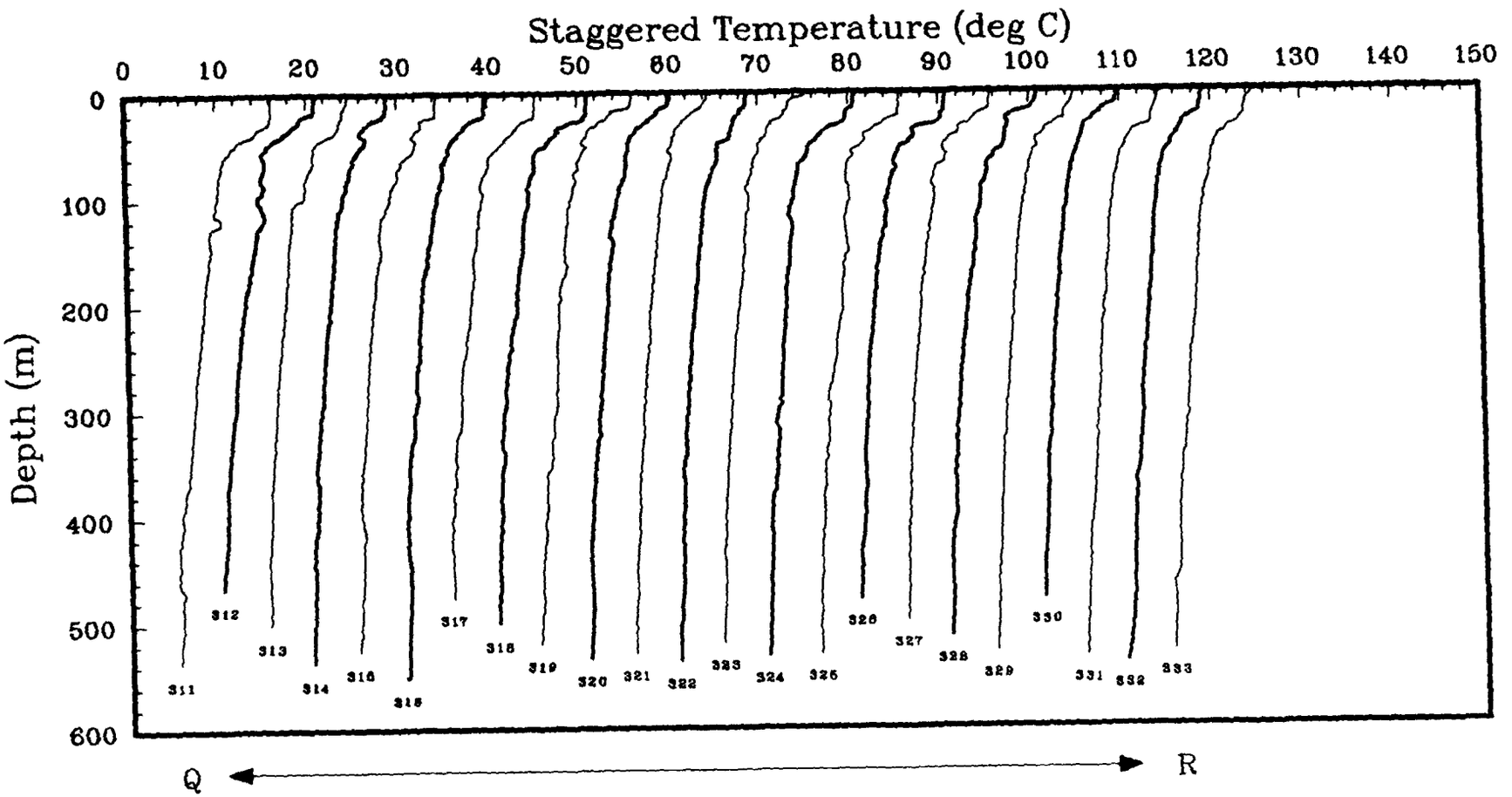

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
Q
R

Figure 16(f).

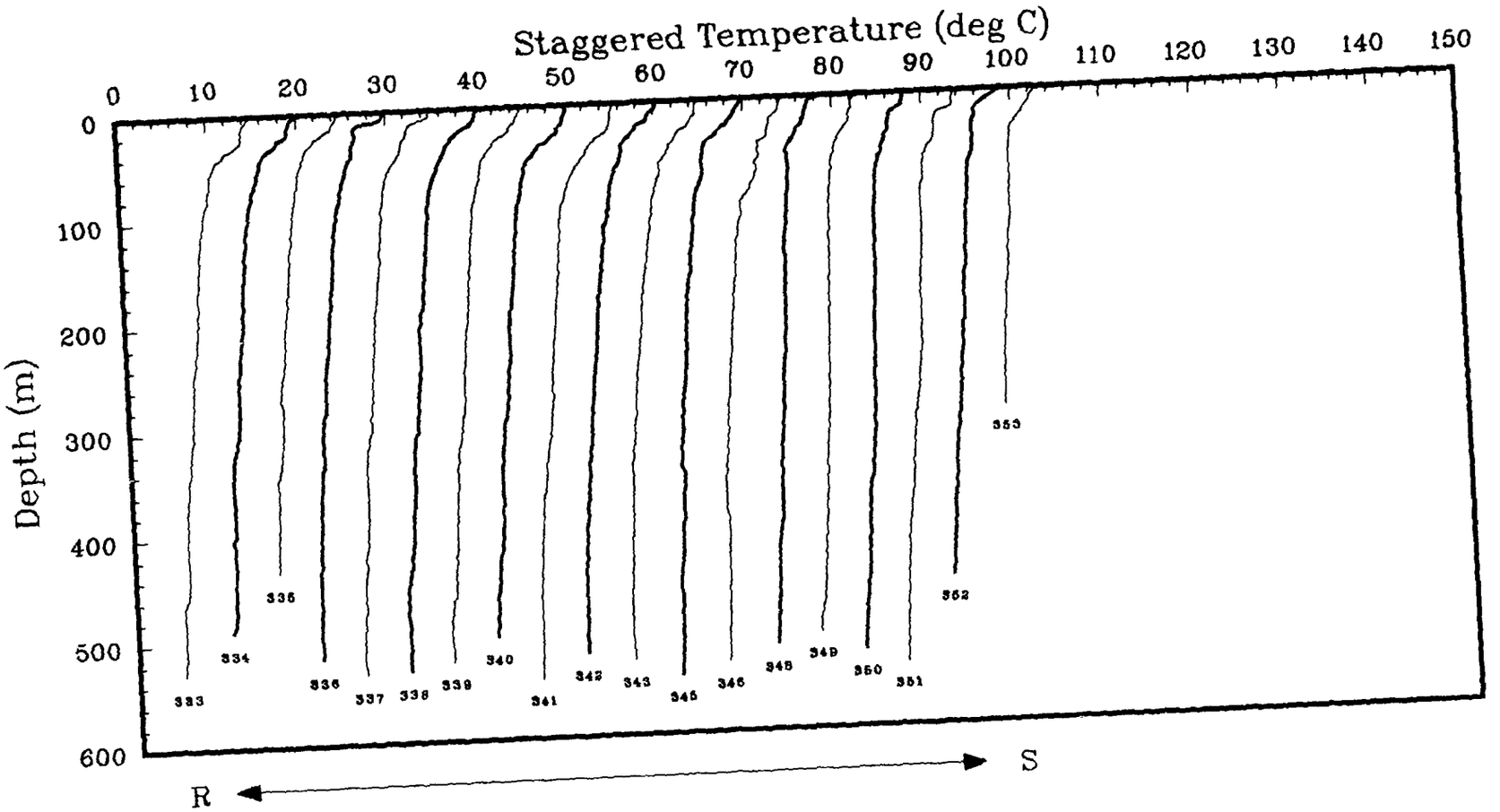

Staggered Temperature (deg C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Depth (m)
0
100
200
300
400
500
600
333
334
335
336
337
338
339
340
341
342
343
345
346
348
349
350
351
352
353
R
S

Figure 16(g).

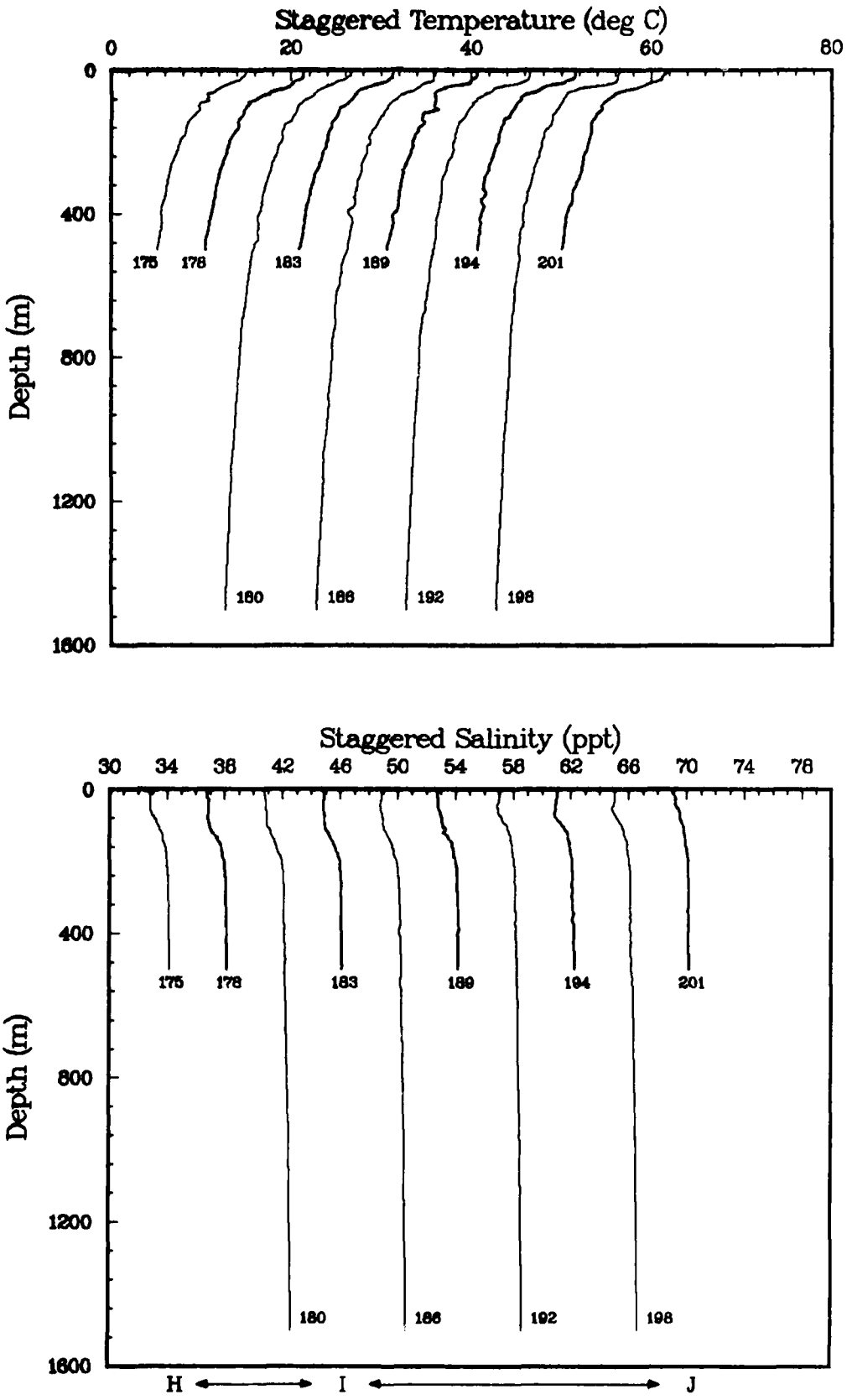


Figure 17(a): Temperature profiles, staggered by multiples of 5C, and salinity profiles, staggered by multiples of 4 ppt.

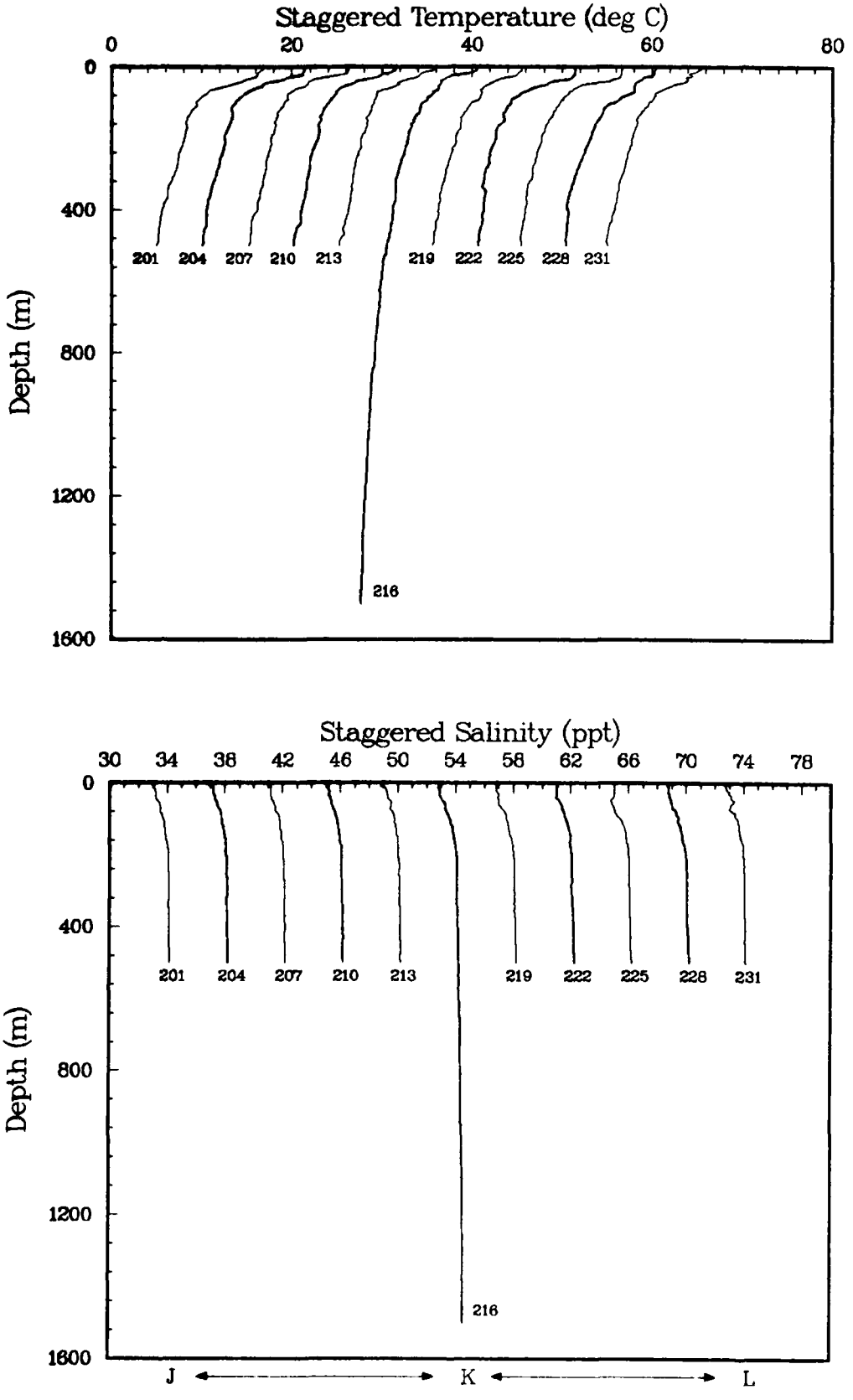

Staggered Temperature (deg C)
0
20
40
60
80
0
400
800
1200
1600
Depth (m)
201
204
207
210
213
219
222
225
228
231
216
Staggered Salinity (ppt)
30
34
38
42
46
50
54
58
62
66
70
74
78
0
400
800
1200
1600
Depth (m)
201
204
207
210
213
219
222
225
228
231
216
J
K
L

Figure 17(b).

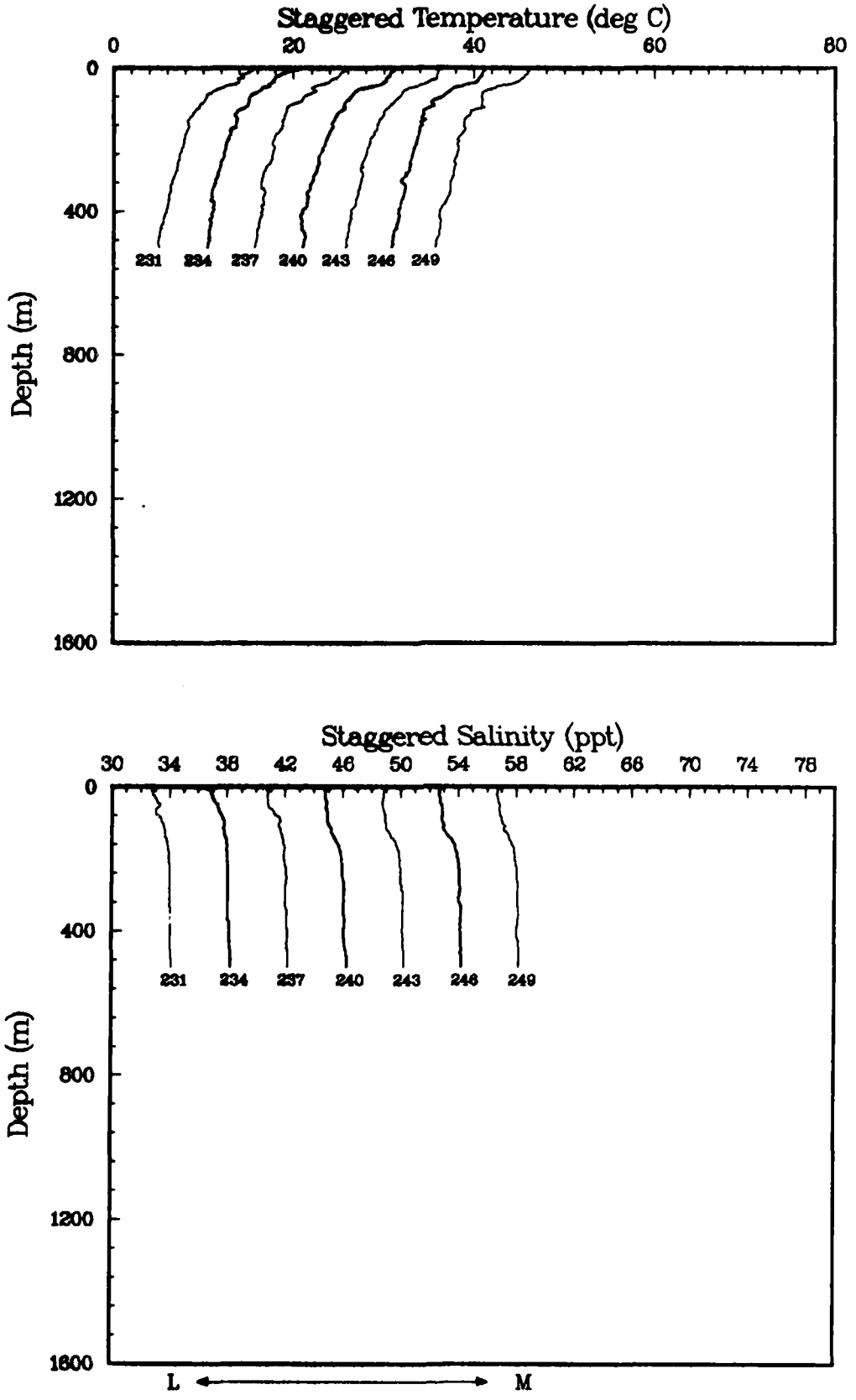

Staggered Temperature (deg C)
0
20
40
60
80
0
400
800
1200
1600
Depth (m)
231
234
237
240
243
246
249
Staggered Salinity (ppt)
30
34
38
42
46
50
54
58
62
66
70
74
78
0
400
800
1200
1600
Depth (m)
231
234
237
240
243
246
249
L
M

Figure 17(c).

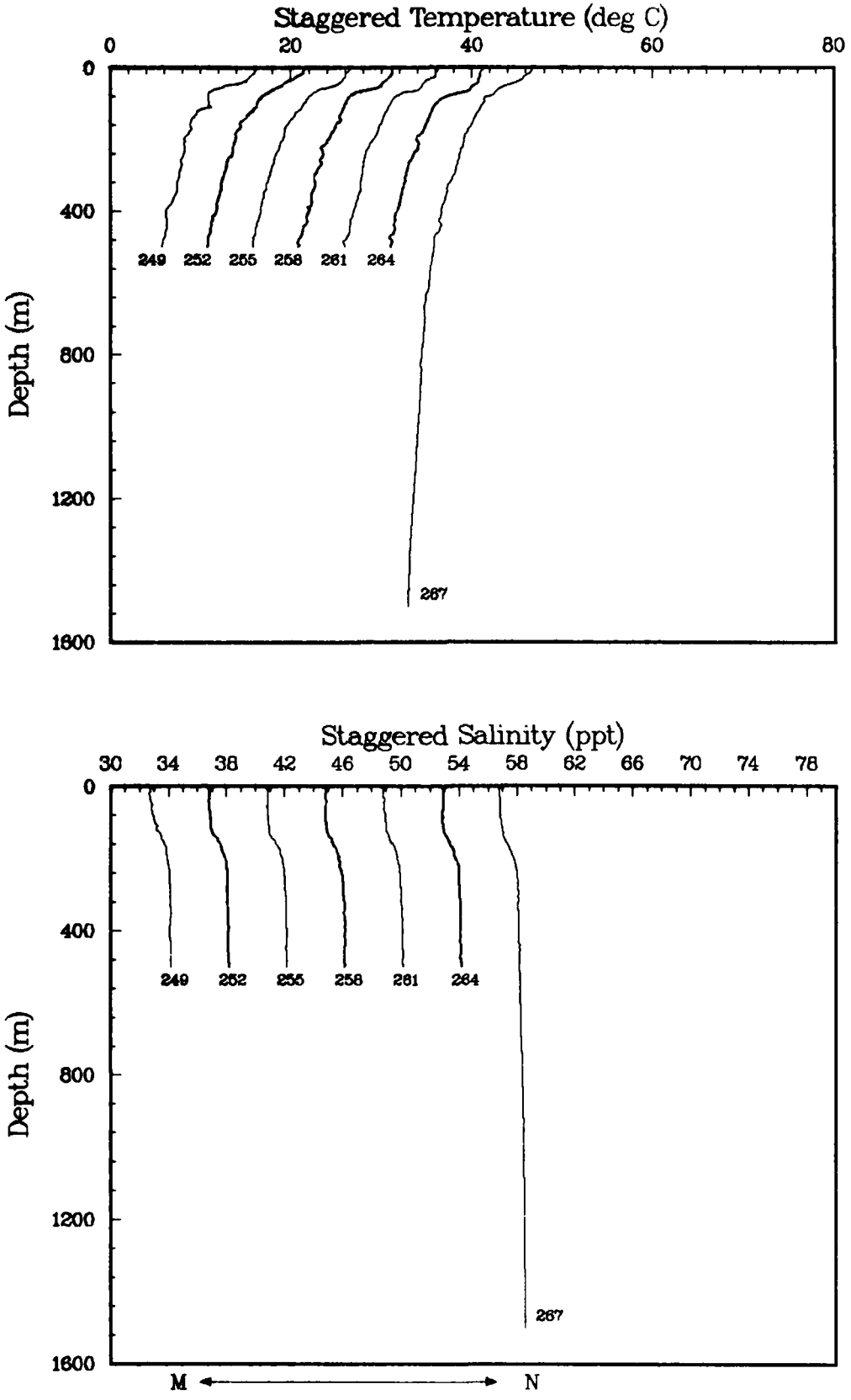

Staggered Temperature (deg C)
0
20
40
60
80
0
400
800
1200
1600
Depth (m)
249
252
255
258
261
264
267
Staggered Salinity (ppt)
30
34
38
42
46
50
54
58
62
66
70
74
78
0
400
800
1200
1600
Depth (m)
249
252
255
258
261
264
267
M
N

Figure 17(d).

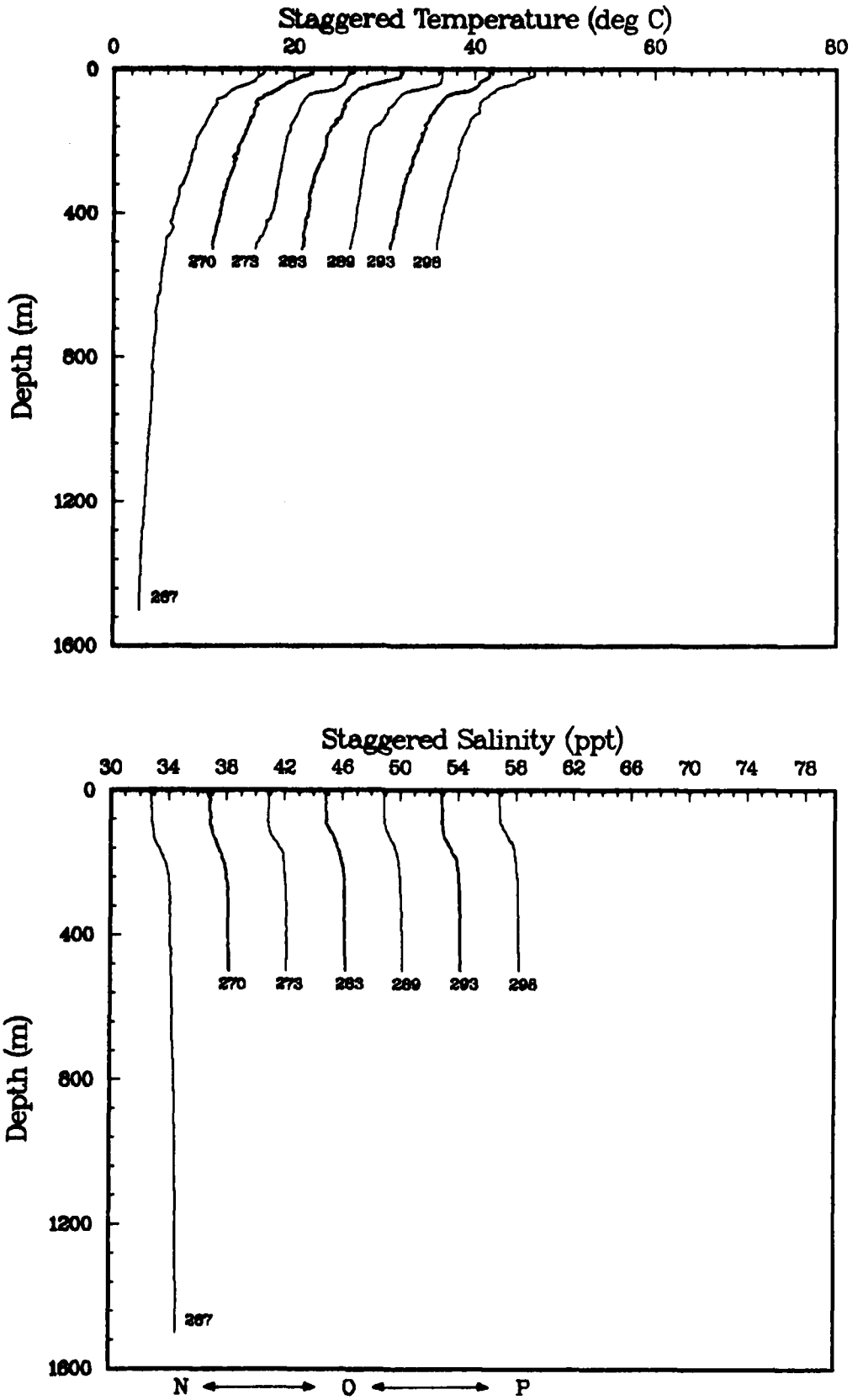

Staggered Temperature (deg C)
0
20
40
60
80
0
400
800
1200
1600
Depth (m)
270
273
283
289
293
298
267
Staggered Salinity (ppt)
30
34
38
42
46
50
54
58
62
66
70
74
78
0
400
800
1200
1600
Depth (m)
270
273
283
289
293
298
267
N
O
P

Figure 17(e).

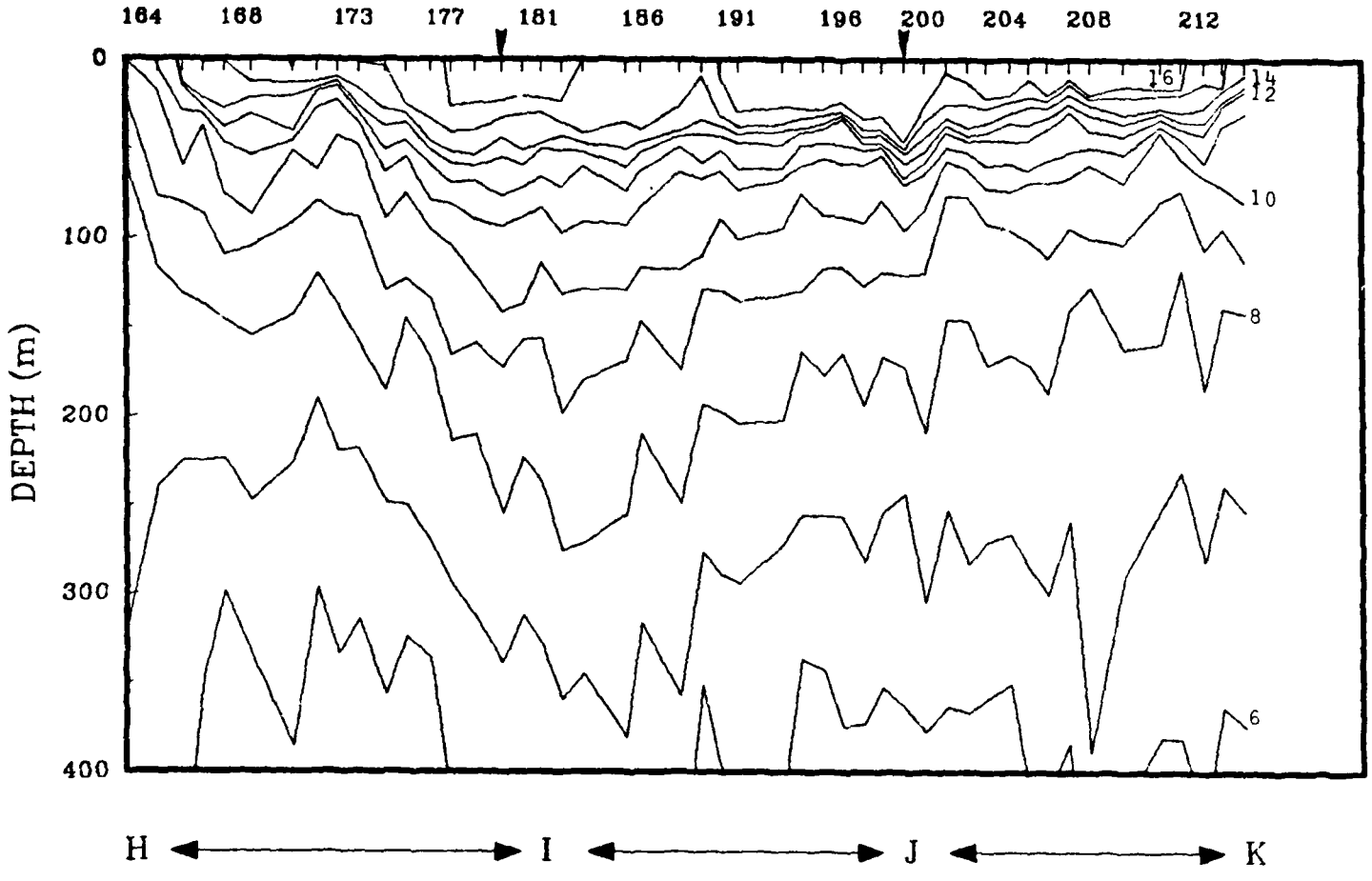


Figure 18(a): Isotherms from XBT's and CTD's. Tick marks along the horizontal axis show station positions. Some station numbers are shown. Arrows indicate the positions where the cruise track changed direction.

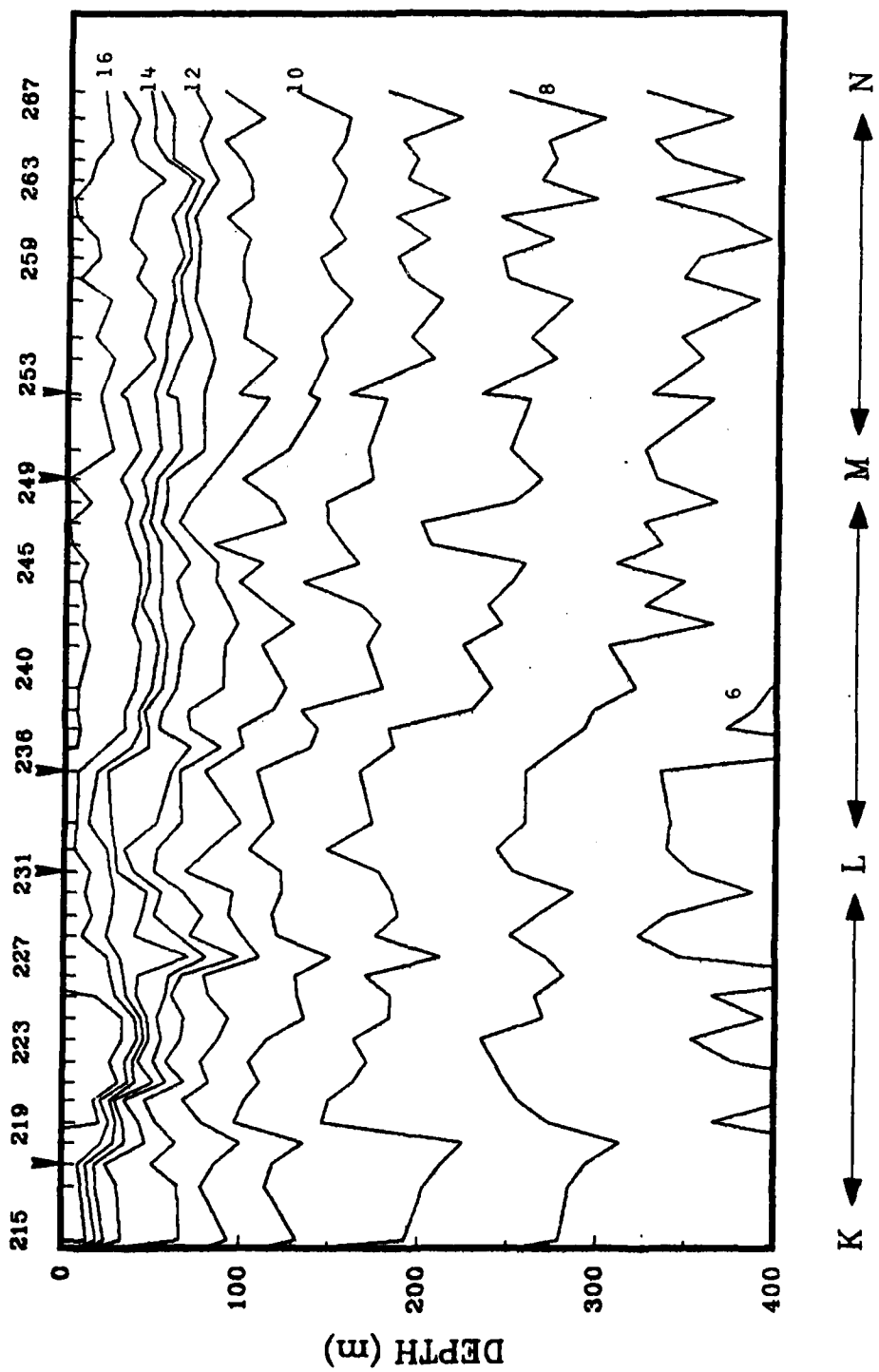

DEPTH (m)
0
100
200
300
400
215
219
223
227
231
236
240
245
249
253
259
263
267
16
14
12
10
8
6
K
L
M
N

Figure 18(b).

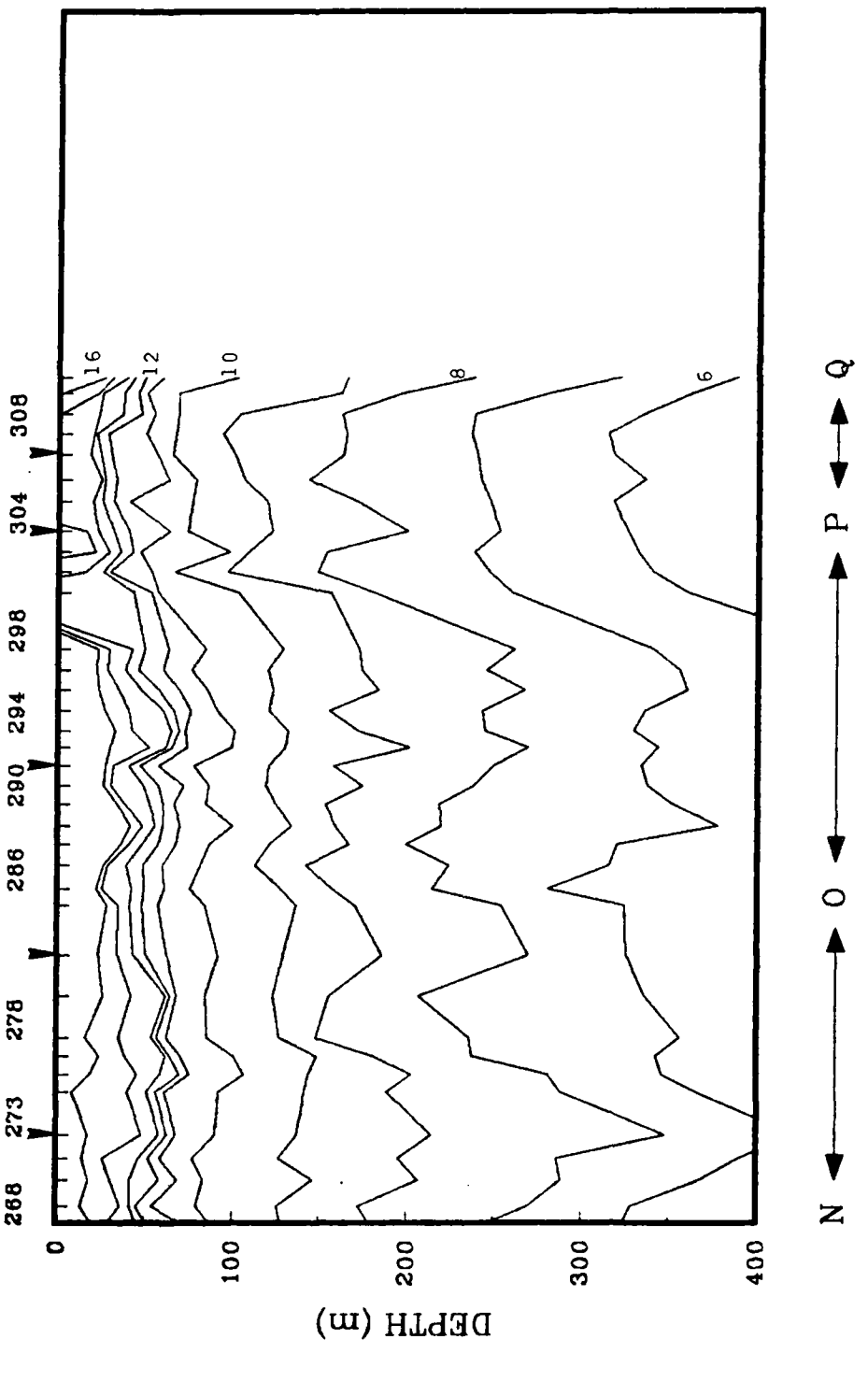

DEPTH (m)
0
100
200
300
400
268
273
278
286
290
294
298
304
308
16
12
10
8
6
N
O
P
Q

Figure 18(c).

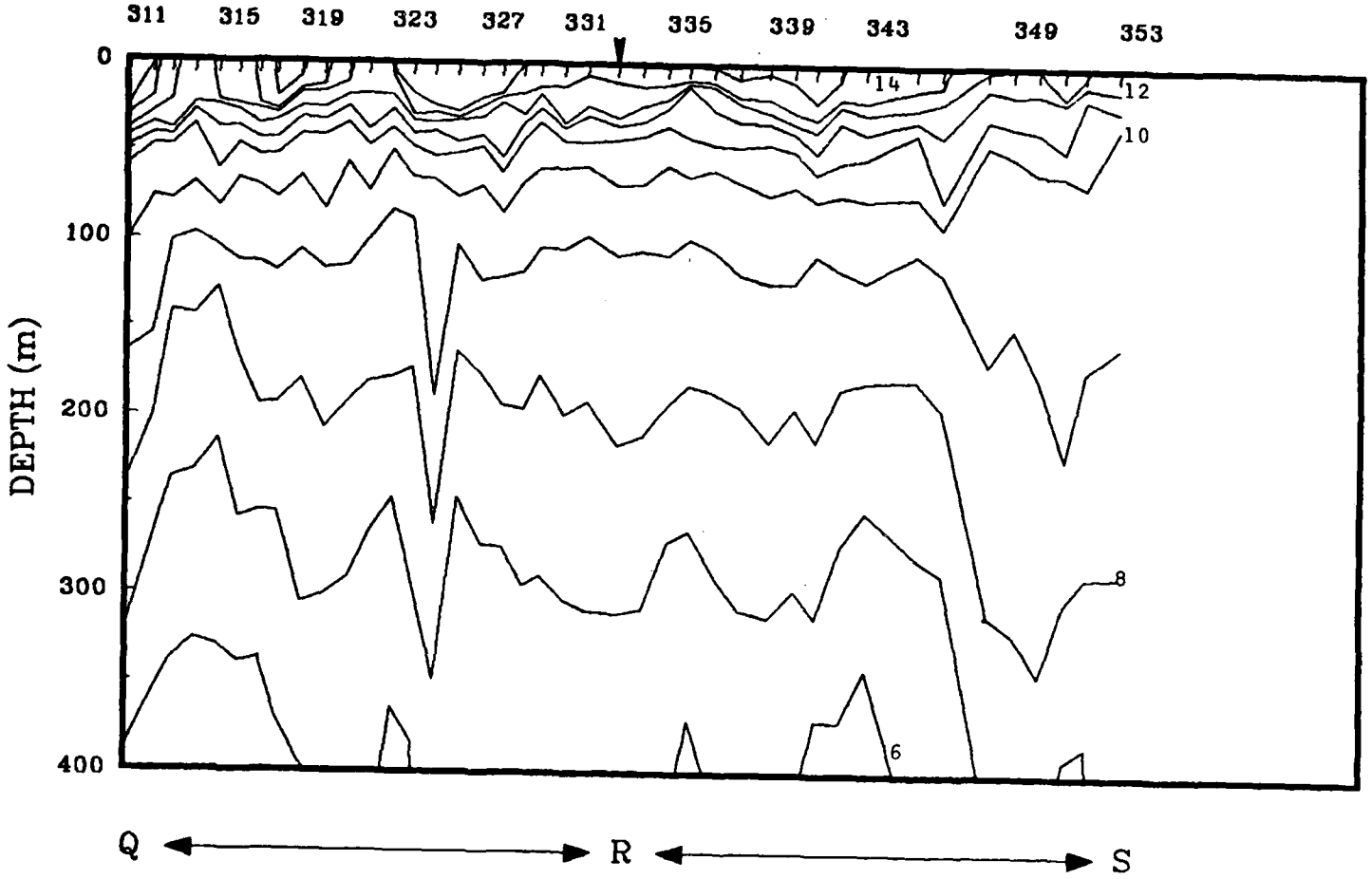

311
315
319
323
327
331
335
339
343
349
353
0
100
200
300
400
DEPTH (m)
14
12
10
8
6
Q
R
S

Figure 18(d).

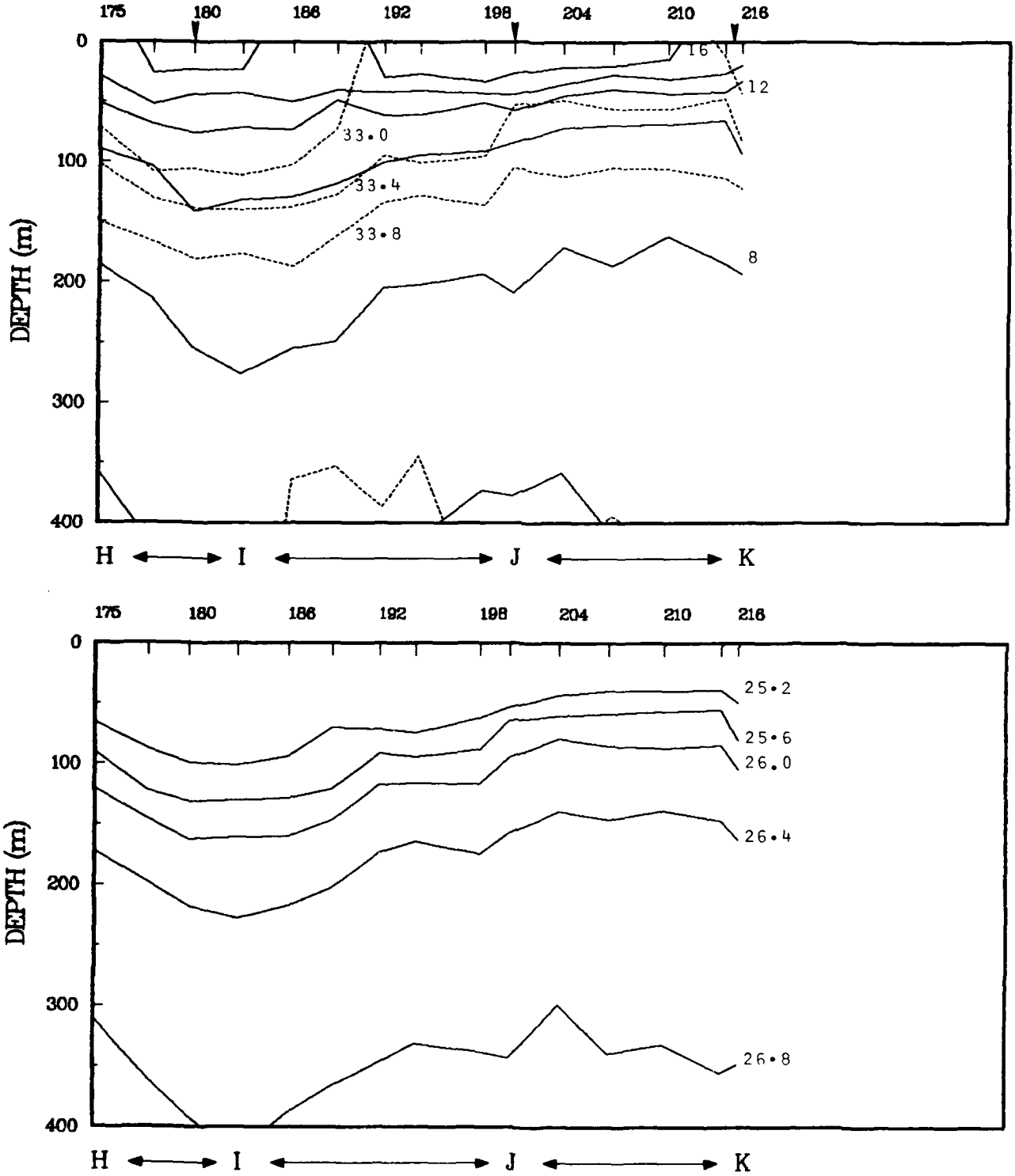


Figure 19(a): Isopleths of temperature, salinity and sigma-t from the CTD's.

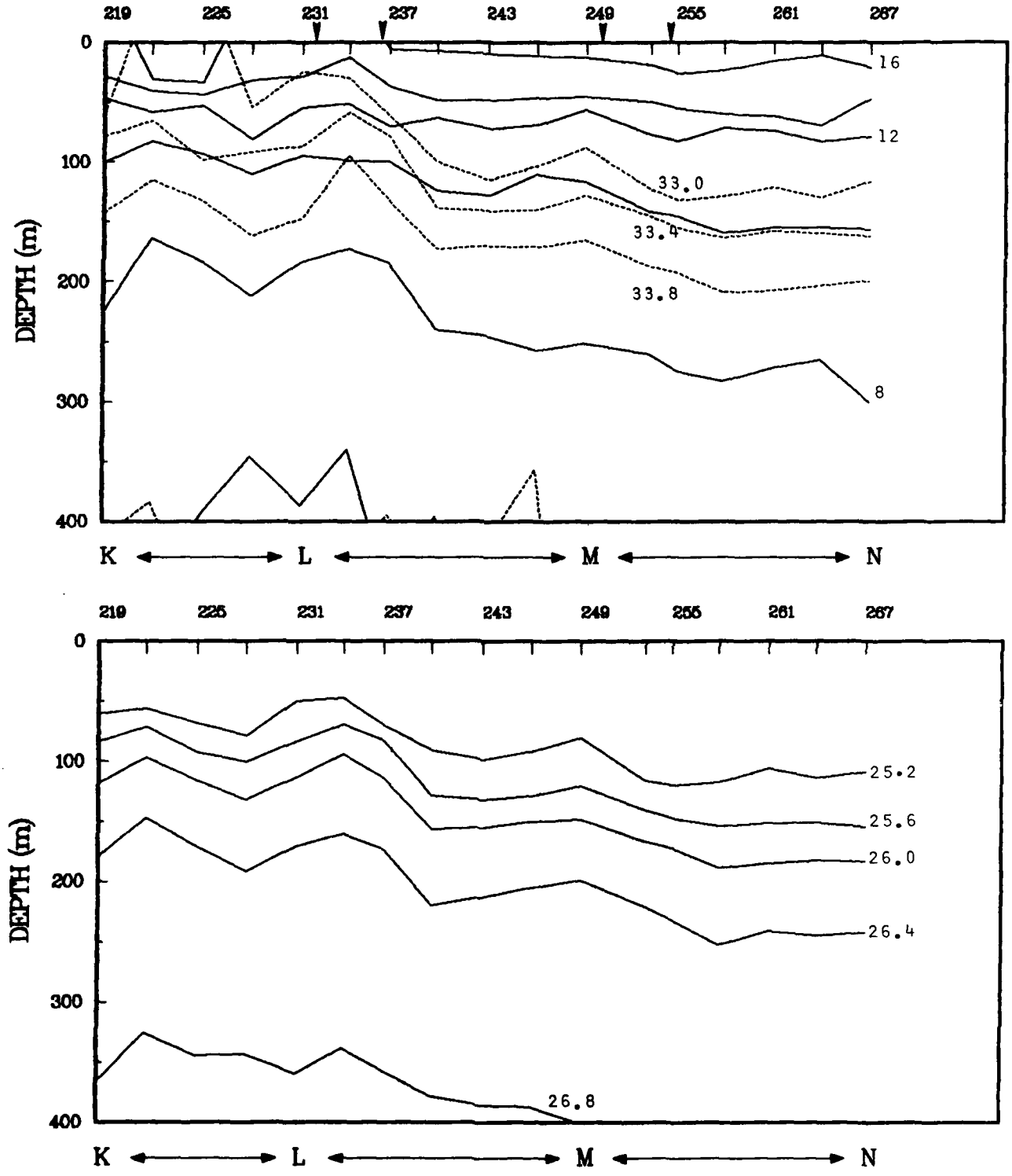

219
225
231
237
243
249
255
261
267
0
100
200
300
400
DEPTH (m)
16
12
33.0
33.4
33.8
8
K
L
M
N
25.2
25.6
26.0
26.4
26.8

Figure 19(b).

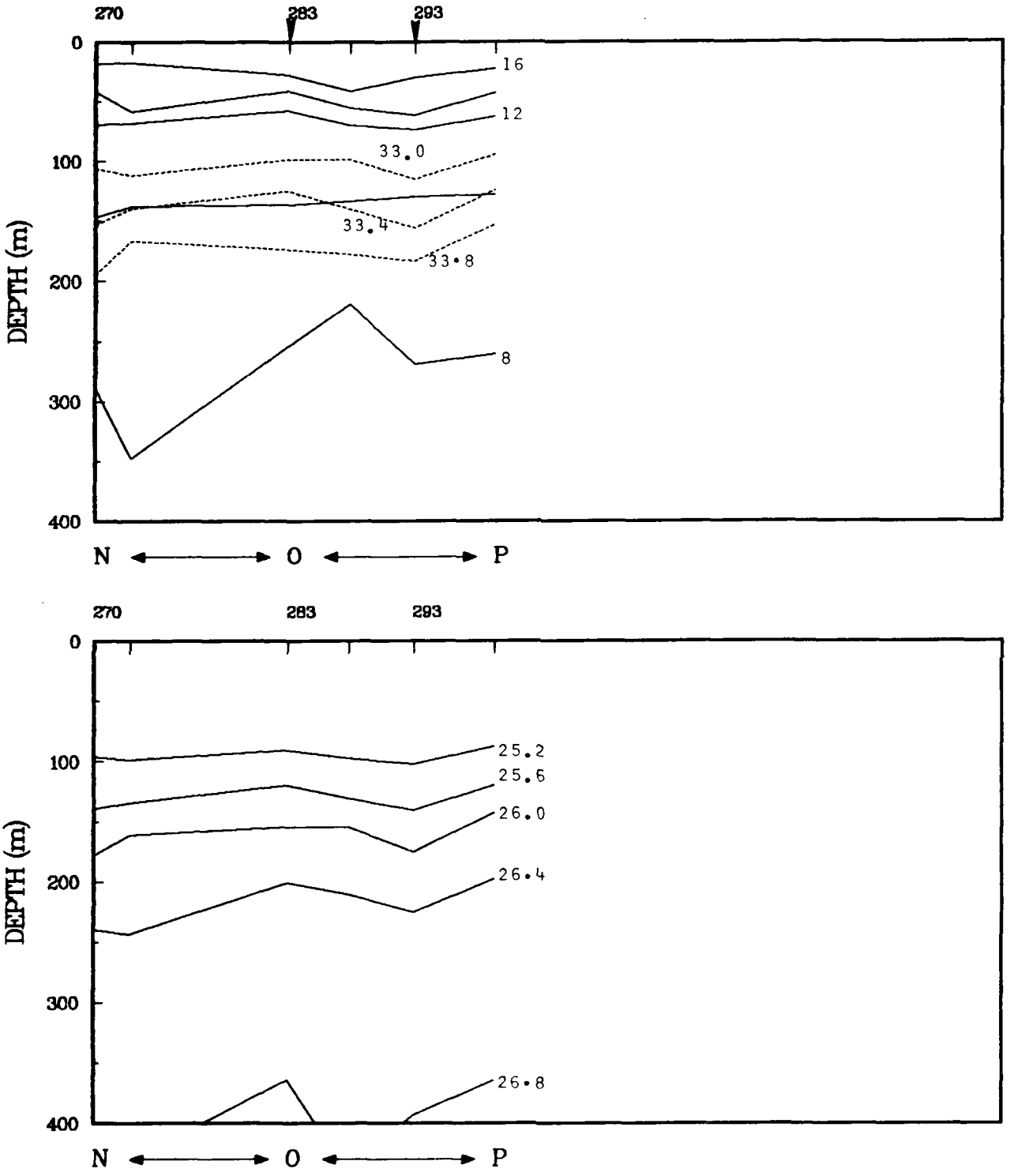

270
283
293
0
100
200
300
400
DEPTH (m)
16
12
33.0
33.4
33.8
8
N
O
P
270
283
293
0
100
200
300
400
DEPTH (m)
25.2
25.6
26.0
26.4
26.8
N
O
P

Figure 19(c).

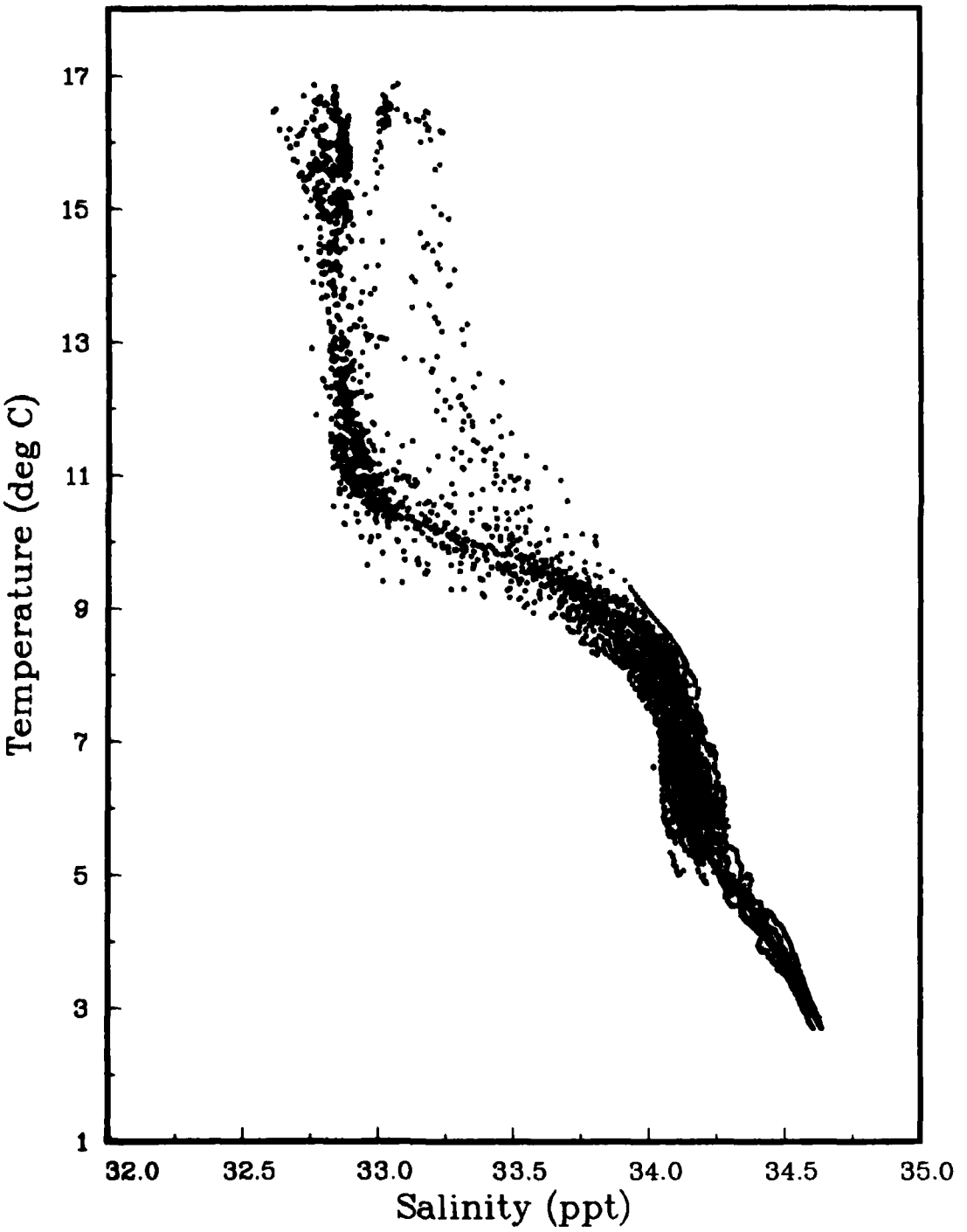


Figure 20: T-S pairs from the CTD casts for OPTOMA2, Leg II.

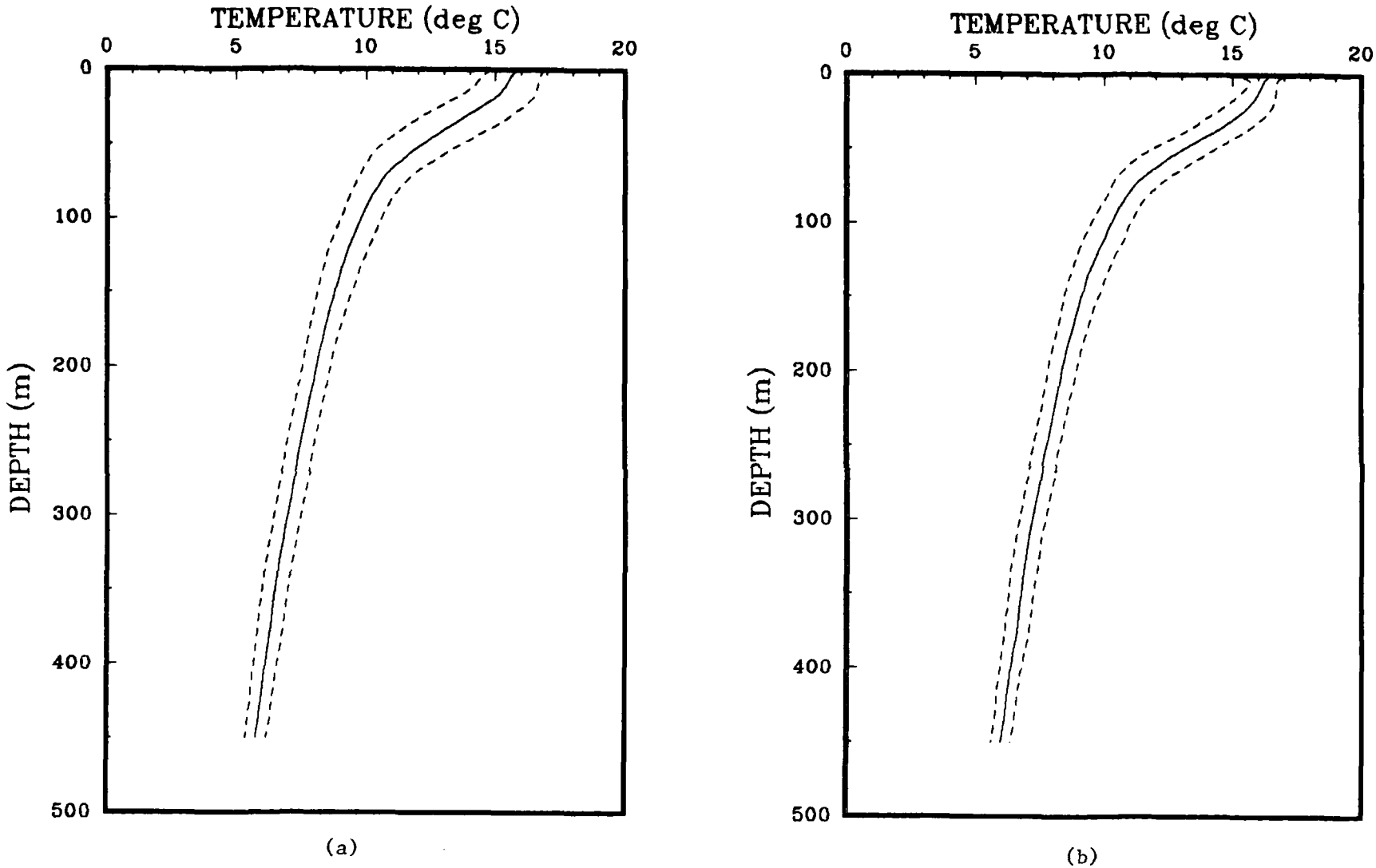


Figure 21: Profiles of $\overline{T(z)}$ with + and - the standard deviation from (a) XBT's and CTD's and (b) CTD's only.

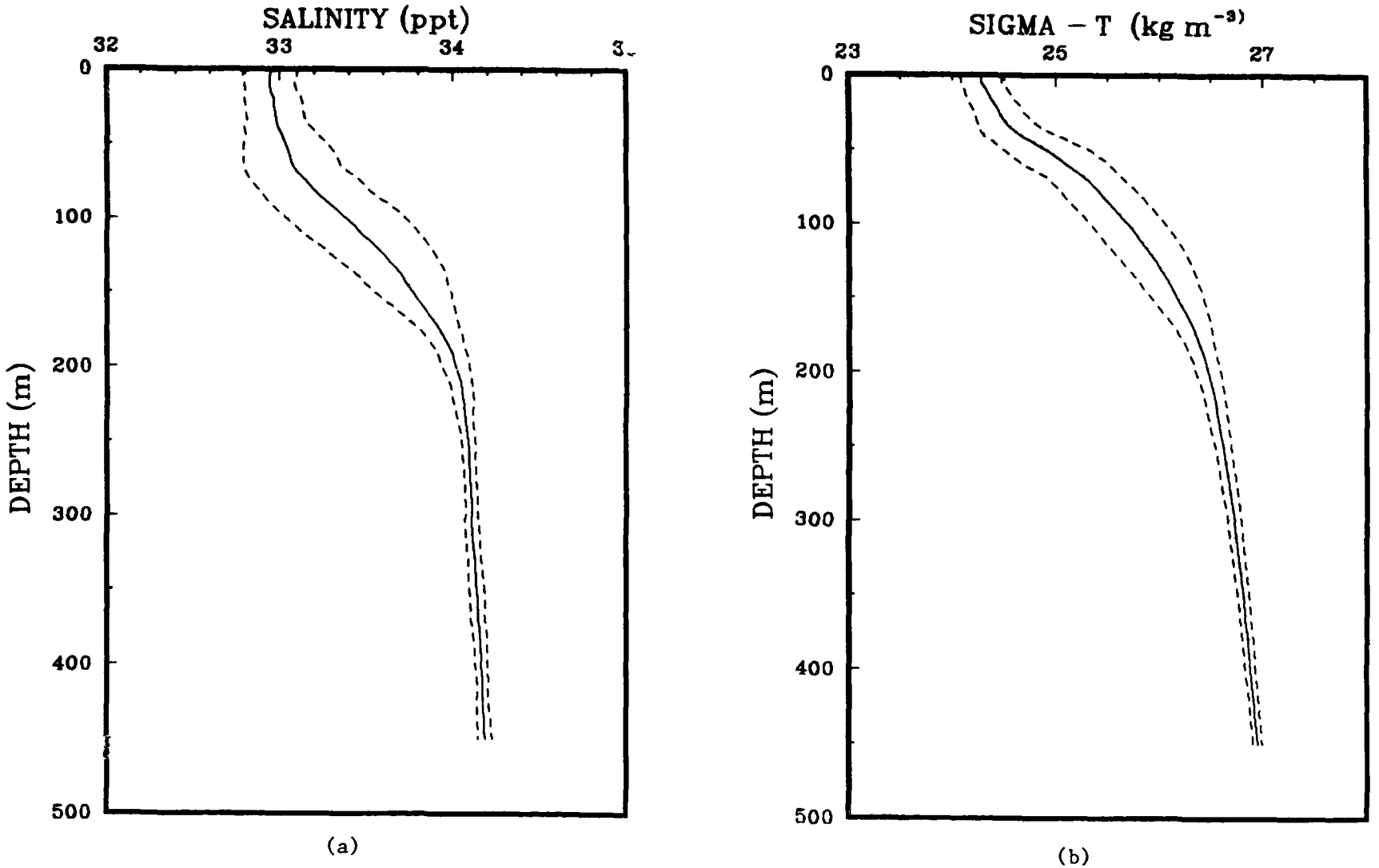


Figure 22: Profiles of (a) mean salinity and (b) mean sigma-t, with + and - the standard deviations, from the CTD's.

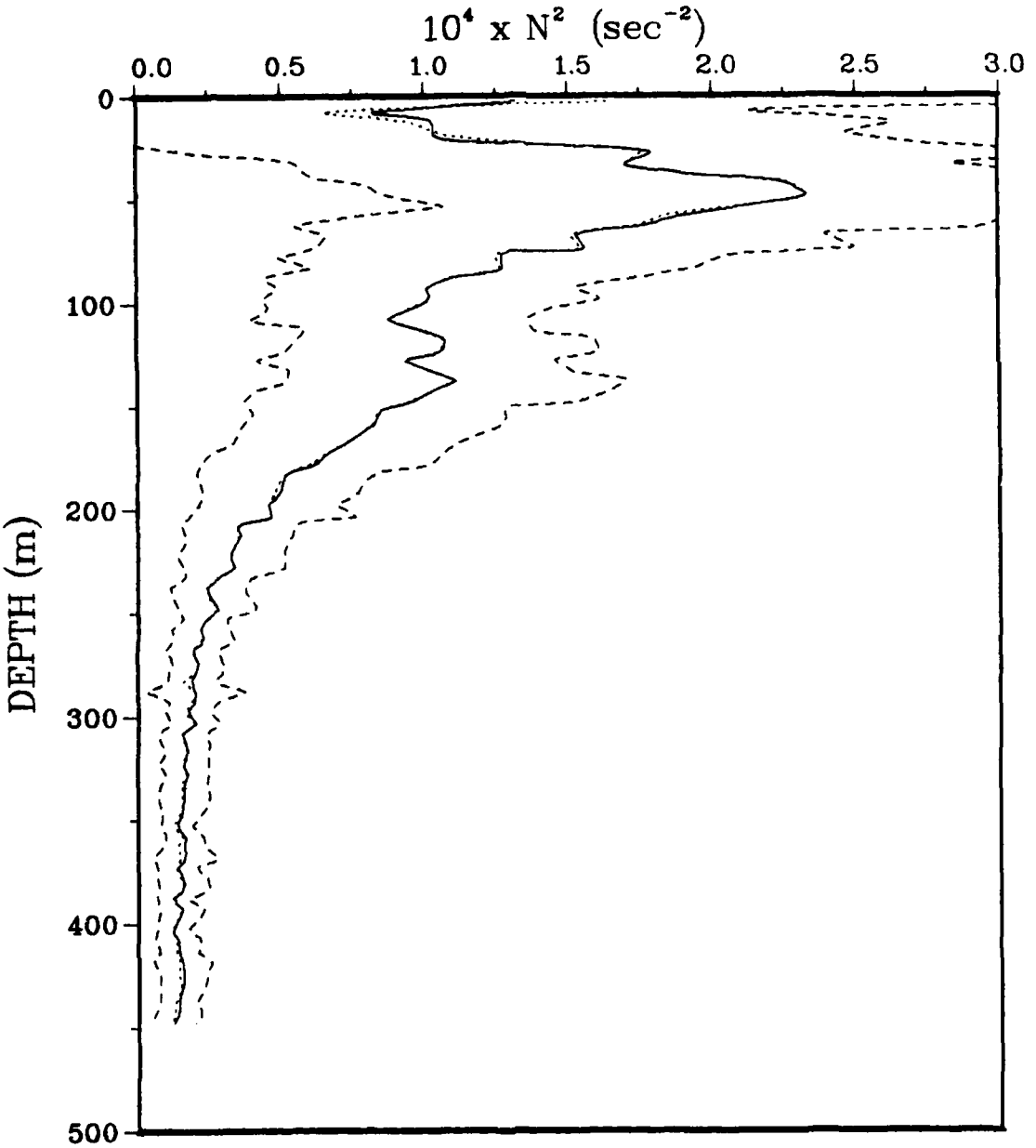


Figure 23: Profiles of $\overline{N^2(z)}$ (——), with + and - the standard deviation (----), and the profile of N^2 from $\overline{T(z)}$ and $\overline{S(z)}$ (....).

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Leg I - Prof. Christopher N.K. Mooers, NPS, Chief Scientist
Dr. Jerome A. Smith, NPS, Party Chief
Dr. Robert Miller, Harvard
Mr. Everett (Skip) Carter, Harvard
Ms. Nadia Pinardi, Harvard
AG3 Beverly Carnes, FNOC
DS3 Steve Lewis, FNOC

Leg II - Prof. Allan R. Robinson, Harvard, Chief Scientist
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Ms. Denise Hagan, JPL
ENS Diane Durban, USN, NPS
Mr. Everett (Skip) Carter, Harvard
Ms. Nadia Pinardi, Harvard
AG3 Bill Sparkman, FNOC
Mr. M. Kirk Fleming, Humboldt State

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REFERENCE

Lewis, E.L. and R.G. Perkin, 1981: The Practical Salinity Scale 1978: conversion of existing data. Deep Sea Res. 28A, 307-328.

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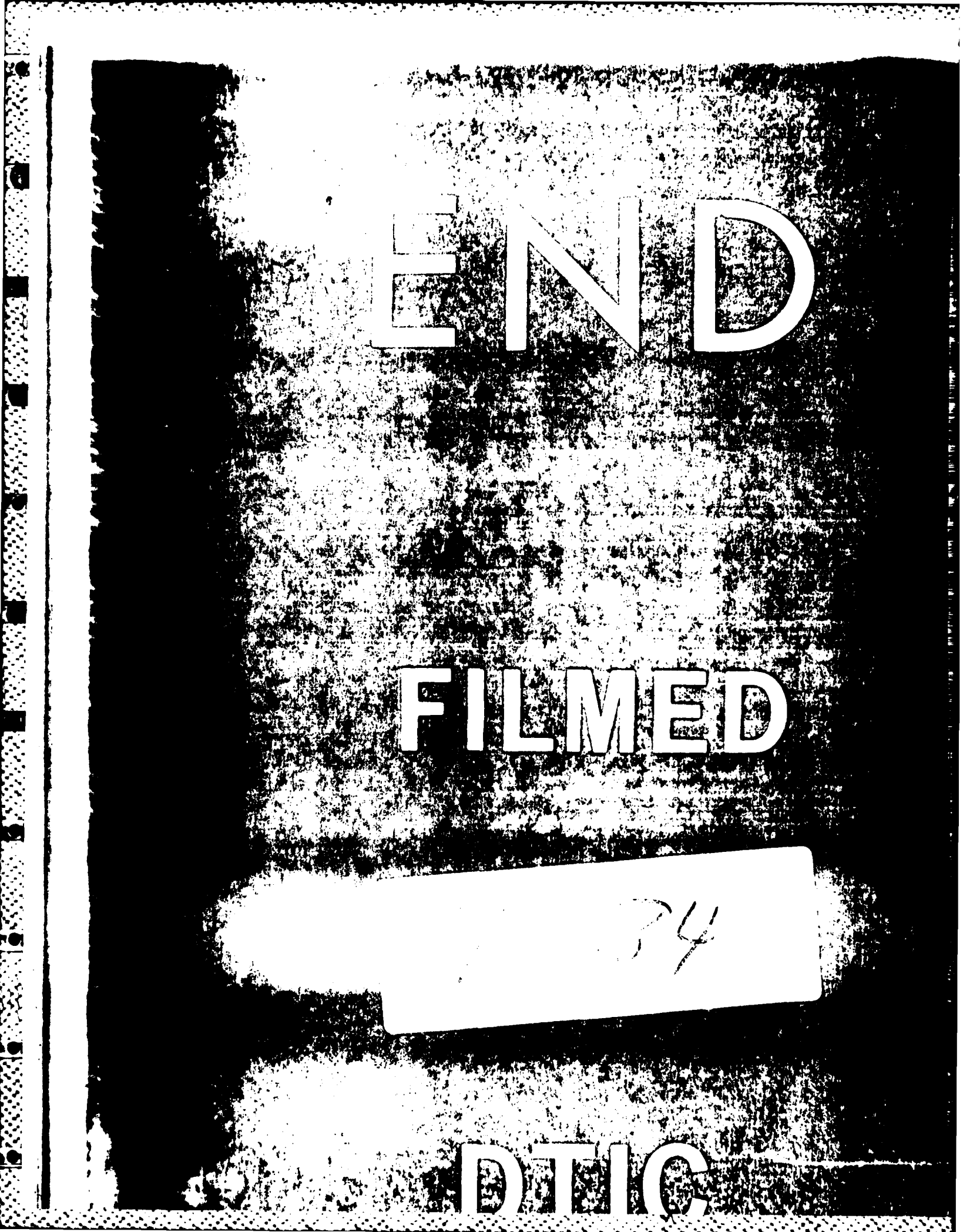
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